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Diyaliz Hastalarında Ekokardiyografik Bulgularla Bilişsel Fonksiyonlar ve Depresyon Arasındaki İlişki

The Relationship Between Echocardiographic Findings, Cognitive Functions And Depression In Dialysis Patients

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ABSTRACT

Introduction: Quality of life is associated with increased morbidity and mortality. It is mainly determined with depression and cognitive functions. Cognitive decline is exacerbated by both microvascular and macrovascular disease due to cerebrovascular damage even in early stages of CRF. Given these close relationship between cardiovascular disease (CVD) and chronic renal failure (CRF), this study aimed to investigate the relationship between depression and cognitive dysfunction and cardiac functions. Material And Method: The sample included 55 patients receiving dialysis, 37 undergoing hemodialysis and 18 undergoing peritoneal dialysis. The Beck Depression Inventory (BDI) was used to evaluate for the presence of depression and the Mini-Mental State Examination (MMSE) was used to assess cognitive function. Echocardiography was performed to assess cardiac function. Results: No significant correlation was found between the MMSE score and BDI with echocardiographic parameters in the total sample. Subgroup of 37 hemodialysis patients, a weak positive correlation was observed between the BDI score. Discussion: A key finding of this study was a positive correlation between left ventricular end-diastolic volume and stroke volume and depression in hemodialysis patients. This finding aligns with previous researchs demonstrating a link between cardiovascular events and depression. On the other hand our study found no association between echocardiographic parameters and cognitive function in the total dialysis population, nor in the hemodialysis and peritoneal dialysis subgroups consistent with these previous studies. Conclusion: This study demonstrated association between depression and cardiovascular events and no correlation between cognitive function and echocardiographic parameters. Further studies including larger numbers of patients are needed.

Keywords: *Dialysis and depression, Dialysis and cognitive functions, Dialysis and echocardiographic findings, Echocardiographic findings and cognitive functions*

ÖZ

Amaç: Yaşam kalitesi, artmış morbidite ve mortalite ile ilişkilidir. Esas olarak yaşam kalitesini etkileyen en önemli iki unsur kişinin depresyonu ve bilişsel fonksiyonlarıdır. Bilişsel gerileme, kronik böbrek yetmezliğinin (KBY) erken evrelerinde bile serebrovasküler hasara bağlı olarak hem mikrovasküler hem de makrovasküler hastalıkla şiddetlenir. Bu hastalığa sahip kişilerde bilişsel işlev bozukluğu prevalansı %30-60'a kadar ulaşmaktadır. Diyaliz hastalarında ise bilişsel işlev bozukluğu prevalansının daha yüksek kardiyovasküler hastalık (KVH) prevalansı nedeni ile daha fazla olması beklenir. KVH ve KBY arasındaki yakın ilişki göz önüne alındığında, bu çalışma depresyon, kognitif disfonksiyon ile kardiyak fonksiyonlar arasındaki ilişkiyi araştırmayı amaçlamıştır. Gereç ve Bulgular: Örneklem sayısı diyaliz tedavisi gören 37'si hemodiyaliz ve 18'i periton diyalizi olmak üzere 55 hastadan oluşmaktadır. Katılımcılara Beck Depresyon Envanteri (BDE), Mini-Mental Test (MMSE) ve ekokardiyografi uygulanarak veriler toplandı. Bulgular: Tüm hastalar arasında MMSE skoru ve BDI ile ekokardiyografik parametreler arasında anlamlı bir korelasyon bulunamadı. 37 hemodiyaliz hastasından oluşan alt grupta ise BDE skoru ile kardiyak fonksiyonlar arasında pozitif yönde bir korelasyon gözlendi. Tartışma: Hemodiyaliz hastalarında sol ventrikül diyastol sonu hacmi ve atım hacmi ile depresyon arasında pozitif bir korelasyon vardır. Bu bulgu, kardiyovasküler olaylar ile depresyon arasında bir bağlantı olduğunu gösteren önceki araştırmalarla uyumludur. Öte yandan, çalışmamızda tüm diyaliz popülasyonunda, hemodiyaliz ve periton diyalizi alt gruplarında ekokardiyografik parametreler ile bilişsel işlevler arasında önceki çalışmalara benzer şekilde anlamlı ilişki bulunamamıştır.

Anahtar Kelimeler: *Diyaliz ve depresyon, Diyaliz ve bilişsel işlevler, Diyaliz ve ekokardiyografik bulgular, Ekokardiyografik bulgular ve bilişsel fonksiyonlar*

INTRODUCTION

Depression is a highly prevalent psychological comorbidity among patients undergoing dialysis (1). It negatively impacts quality of life in individuals with chronic renal failure (CRF), and this combination of depression and diminished quality of life is associated with increased comorbidity rates (2,3). Moreover, depression is linked to higher rates of hospitalization. Cardiovascular disease (CVD) is also prevalent, affecting 80% of individuals with CRF and includes conditions such as atherosclerotic heart disease, congestive heart failure, valvular disease, and pericardial disease. Notably, renal failure is a common comorbidity in patients with congestive heart failure (4,5). The presence of depression in patients with CKD and CVD is associated with significantly elevated mortality rates compared to those without depression (1,4). Therefore, effective management of depression may contribute to a reduction in cardiovascular events in this population (1,7). Cognitive dysfunction, encompassing impairments in mental alertness, attention, concentration, and perceptual-motor coordination, is prevalent in individuals with CKD (6). Estimates suggest that 30 to 60% of dialysis patients experience cognitive dysfunction which independently influences both morbidity and mortality (7). The high prevalence of both cognitive dysfunction and CVD in dialysis patients may be linked. Cognitive decline is accelerated by microvascular and macrovascular disease, and it is well-established that cerebrovascular disease negatively impacts cognitive function. The presence of cerebrovascular damage, even in the early stages of CKD, may contribute to the increased frequency of cognitive dysfunction observed in dialysis patients and its association with CVD. This study aimed to determine the prevalence of depression and investigate the relationship between cognitive dysfunction and cardiac function, as assessed by echocardiography, in patients with CKD.

MATERIAL and METHOD

Sample Selection

This cross section study was conducted at university hospital. The sample included 55 patients receiving dialysis, comprising 37 undergoing hemodialysis and 18 undergoing peritoneal dialysis. Patients were eligible for inclusion if they were over 18 years of age, receiving hemodialysis or peritoneal dialysis, had no communication difficulties, and provided informed consent. Patients were excluded from the study if they had mental retardation, refused to complete the Beck Depression Inventory (BDI) or Mini-Mental State Examination (MMSE), had an acute cardiovascular event within the previous 3 months (including acute myocardial infarction, acute cerebrovascular event, peripheral vascular event, and amputation), had active malignancy, used antidepressant medications, antipsychotic medications, or medications known to cause mood disturbances, refused echocardiographic assessment.

Beck Depression Inventory

BDI, a widely used and validated tool for assessing depression in clinical settings, was administered to participants (8). Developed in 1961, the BDI is favored for its ease of administration and brevity (8). This 21-item self-report questionnaire, as detailed in Appendix 1, uses a four-point Likert scale for each item, with responses ranging from 0 to 3. Total scores are categorized as follows: 0-9, normal; 10-18, mild depression; 19-29, moderate depression; and 30-63, severe depression (7, 9).

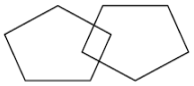
Appendix 1: Beck's Depression Inventory

1.
0 I do not feel sad.
1 I feel sad
2 I am sad all the time and I can't snap out of it.
3 I am so sad and unhappy that I can't stand it.
2.
0 I am not particularly discouraged about the future.
1 I feel discouraged about the future.
2 I feel I have nothing to look forward to.

3 I feel the future is hopeless and that things cannot improve.
3.
0 I do not feel like a failure.
1 I feel I have failed more than the average person.
2 As I look back on my life, all I can see is a lot of failures.
3 I feel I am a complete failure as a person.
4.
0 I get as much satisfaction out of things as I used to.
1 I don't enjoy things the way I used to.
2 I don't get real satisfaction out of anything anymore.
3 I am dissatisfied or bored with everything.
5.
0 I don't feel particularly guilty
1 I feel guilty a good part of the time.
2 I feel quite guilty most of the time.
3 I feel guilty all of the time.
6.
0 I don't feel I am being punished.
1 I feel I may be punished.
2 I expect to be punished.
3 I feel I am being punished.
7.
0 I don't feel disappointed in myself.
1 I am disappointed in myself.
2 I am disgusted with myself.
3 I hate myself.
8.
0 I don't feel I am any worse than anybody else.
1 I am critical of myself for my weaknesses or mistakes.
2 I blame myself all the time for my faults.
3 I blame myself for everything bad that happens.
9.
0 I don't have any thoughts of killing myself.
1 I have thoughts of killing myself, but I would not carry them out.
2 I would like to kill myself.
3 I would kill myself if I had the chance.
10.
0 I don't cry any more than usual.
1 I cry more now than I used to.
2 I cry all the time now.
3 I used to be able to cry, but now I can't cry even though I want to.
11.
0 I am no more irritated by things than I ever was.
1 I am slightly more irritated now than usual.
2 I am quite annoyed or irritated a good deal of the time.
3 I feel irritated all the time.
12.
0 I have not lost interest in other people.
1 I am less interested in other people than I used to be.
2 I have lost most of my interest in other people.
3 I have lost all of my interest in other people.

13.
0 I make decisions about as well as I ever could.
1 I put off making decisions more than I used to.
2 I have greater difficulty in making decisions more than I used to.
3 I can't make decisions at all anymore.
14.
0 I don't feel that I look any worse than I used to.
1 I am worried that I am looking old or unattractive.
2 I feel there are permanent changes in my appearance that make me look unattractive
3 I believe that I look ugly.
15.
0 I can work about as well as before.
1 It takes an extra effort to get started at doing something.
2 I have to push myself very hard to do anything.
3 I can't do any work at all.
16.
0 I can sleep as well as usual.
1 I don't sleep as well as I used to.
2 I wake up 1-2 hours earlier than usual and find it hard to get back to sleep.
3 I wake up several hours earlier than I used to and cannot get back to sleep.
17.
0 I don't get more tired than usual.
1 I get tired more easily than I used to.
2 I get tired from doing almost anything.
3 I am too tired to do anything.
18.
0 My appetite is no worse than usual.
1 My appetite is not as good as it used to be.
2 My appetite is much worse now.
3 I have no appetite at all anymore.
19.
0 I haven't lost much weight, if any, lately.
1 I have lost more than five pounds.
2 I have lost more than ten pounds.
3 I have lost more than fifteen pounds.
20.
0 I am no more worried about my health than usual.
1 I am worried about physical problems like aches, pains, upset stomach, or constipation.
2 I am very worried about physical problems and it's hard to think of much else.
3 I am so worried about my physical problems that I cannot think of anything else.
21.
0 I have not noticed any recent change in my interest in sex.
1 I am less interested in sex than I used to be.
2 I have almost no interest in sex.
3 I have lost interest in sex completely.

Appendix 2: Minimental Test Exam

Maximum score	Patient's score	Questions
5		"What is the year? Season? Date? Day of the week? Month?"
5		"Where are we now: State? County? Town/city? Hospital? Floor?"
3		The examiner names three unrelated objects clearly and slowly, then asks the patient to name all three of them. The patient's response is used for scoring. The examiner repeats them until patient learns all of them, if possible.
5		""I would like you to count backward from 100 by sevens." (93, 86, 79,72, 65, …) Stop after five answers. Alternative: "Spell WORLD backwards." (D-L-R-O-W)
3		"Earlier I told you the names of three things. Can you tell me what those were?"
2		Show the patient two simple objects, such as a wristwatch and a pencil, and ask the patient to name them.
1		"Repeat the phrase: 'No ifs, ands, or buts.'"
3		"Take the paper in your right hand, fold it in half, and put it on the floor." (The examiner gives the patient a piece of blank paper.)
1		"Please read this and do what it says." (Written instruction is "Close our eyes.")
1		"Make up and write a sentence about anything." (This sentence must contain a noun and a verb.)
1		"Please copy this picture." (The examiner gives the patient a blank piece of paper and asks him/her to draw the symbol below. All 10angles must be present and two must intersect.) 
30	Total	

(Adapted from Rovner & Folstein, 198)

Statistical Analysis

Statistical analysis was performed on IBM SPSS Statistics for Windows, version 17.0 (IBM Corp., Armonk, N.Y., USA). The Kolmogorov-Smirnov test was used to assess the normality of data distribution. Descriptive statistics (mean and standard deviation) were calculated. Spearman and Pearson correlation coefficients were used to assess correlations between quantitative variables. For comparisons between groups, independent samples t-tests and one-way analysis of variance (ANOVA) were used for parametric data, while the Mann-Whitney U test and Kruskal-Wallis test were used for non-parametric data. Statistical significance was defined as a p-value less than 0.05.

RESULTS

The study included 55 dialysis patients, comprising 27 females and 28 males. Thirty-seven patients were receiving hemodialysis (19 females, 18 males) and 18 were receiving peritoneal dialysis (8 females, 10 males). The mean age of the participants was 54.0±13.5 years, and the mean duration of dialysis was 54.9±42.2 months. The mean height was 163.1±10.3cm, and the mean weight was 68.8±14.1kg. Among the participants, 25.4% smoked and 3.6% consumed alcohol. Comorbidities included coronary artery disease (10.9%), peripheral artery disease (7.2%), and history of cerebrovascular events (5.4%). The distribution of etiologies of chronic renal failure is presented in Table 3. The mean spKt/V for the entire cohort was 1.9±1.3. Echocardiographic parameters are shown in Table 1.

Table 1. Mean Values Of Echocardiographic Parameters

Echocardiographic Parameters	Mean±SD
Left ventricular mass (g)	237.1±80.1
Left ventricular diastolic diameter(mm)	47±6.2
Left ventricular systolic diameter (mm)	29.7±5.2
Interventricular septum thickness (mm)	12.7±2.5
Posterior wall thickness (mm)	11.9±1.8
Left atrial diastolic diameter (mm)	37.3±7.4
Left atrial systolic diameter (mm)	28.5±4.9
Aortic systolic diameter (mm)	24.8±4.0
Aortic diastolic diameter (mm)	28.4±3.8
Left ventricular end-diastolic volume (mL)	104.2±34.2
Left ventricular end-systolic volume (mL)	38.5±19.0
Cardiac output (L/min)	5.33±1.6
Stroke volume (mL)	64.4±22.9
Ejection fraction (%)	64.4±8.2

BDI score classification, 16 patients were classified as having normal mood, 20 had mild depressive symptoms, 14 had moderate depressive symptoms, and 5 had severe depressive symptoms. Of the 55 participants, 37 had normal cognitive function, 12 had moderate cognitive dysfunction, and 6 had severe cognitive dysfunction, as assessed by the Mini-Mental State Examination (MMSE).

Because the echocardiographic parameters were not normally distributed, as determined by the Kolmogorov-Smirnov test, Spearman's rank-order correlation was used to assess correlations. No significant correlation was found between the MMSE score and echocardiographic parameters in the total sample of 55 dialysis patients (Table 2).

Table 2. Correlation Between Echocardiographic Parameters With Mini-Mental State Examination(MMSE) and Beck Depression Inventory (BDI) Scores In All Dialysis Patients

Echocardiographic Parameters	[α]Mini-Mental State Examination scores (n=55)		[α]Beck Depression Inventory (BDI) scores (n=55)	
	[β]rho	p	[β]rho	p
Left ventricular mass (g)	+0.001	0.996	+0.112	0.416
Left ventricular diastolic diameter (mm)	-0.004	0.977	+0.075	0.584
Left ventricular systolic diameter (mm)	-0.020	0.888	-0.008	0.952
Intraventricular septum thickness (mm)	+0.007	0.961	+0.119	0.388
Posterior wall thickness (mm)	+0.004	0.976	-0.007	0.961
Left atrial diastolic diameter (mm)	-0.143	0.296	-0.213	0.119
Left atrial systolic diameter (mm)	-0.145	0.292	-0.163	0.235
Aortic systolic diameter (mm)	-0.121	0.378	+0.074	0.592
Aortic diastolic diameter (mm)	+0.119	0.387	+0.027	0.845
Left ventricular end-diastolic volume (mL)	-0.134	0.329	+0.170	0.215
Left ventricular end-systolic volume (mL)	-0.103	0.455	-0.007	0.959
Cardiac output (L/min)	-0.119	0.388	+0.202	0.140
Stroke volume (mL)	-0.127	0.357	+0.162	0.236

Ejection fraction (%)	+0.026	0.853	+0.063	0.645

*α:Spearman's rank-order correlation was used to assess correlations. p<0.05 was considered statistically significant
β: Rho is a non-parametric correlation measure.

However, in the subgroup of 37 hemodialysis patients, a weak positive correlation was observed between the BDI score and both left ventricular end-diastolic volume (r=0.328, p=0.047) and stroke volume (r=0.371, p=0.024) (Table 3). No significant correlation was found between the MMSE score and echocardiographic parameters in the hemodialysis subgroup (Table 3). In the subgroup of 18 peritoneal dialysis patients, no significant correlations were found between either the BDI score (Table 4) or the MMSE score (Table 4) and echocardiographic parameters.

Table 3: Correlation Between Echocardiographic Parameters With BDI And MMSE Scores In 37 Hemodialysis Patients

Echocardiographic Parameters	**ᵅBeck Depression Inventory (BDI) scores (n=37)**		**ᵅMini-Mental State Examination(MMSE) scores(n=37)**	
	rho	**p**	**rho**	**p**
Left ventricular mass (g)	+0.320	0.054	-0.021	0.902
Left ventricular end-diastolic volume (mL)	+0.328	0.047*	-0.211	0.209
Left ventricular end-systolic volume (mL)	+0.130	0.442	-0.177	0.294
Cardiac output (L/min)	+0.228	0.175	-0.054	0.751
Stroke volume (mL)	+0.371	0.024*	-0.221	0.188
Ejection fraction (%)	+0.133	0.432	+0.041	0.810

*p<0.05 was considered statistically significant, α:Spearman's rank-order correlation was used to assess correlations. Rho is a non-parametric correlation measure.

Table 4: Correlation Between Echocardiographic Parameters With BDI and MMSE Scores In 18 Peritoneal Dialysis Patients

Echocardiographic Parameters	**ᵅBeck Depression Inventory (BDI) scores (n=18)**		**ᵅMini-Mental State Examination (MMSE) scores (n=18)**	
	ᵝrho	**p**	**ᵝrho**	**p**
Left ventricular mass (g)	-0.204	0.418	-0.231	0.357
Left ventricular end-diastolic volume (mL)	-0.222	0.375	+0.184	0.465
Left ventricular end-systolic volume (mL)	-0.272	0.276	+0.048	0.851
Cardiac output (L/min)	+0.246	0.325	-0.066	0.796
Stroke volume (mL)	-0.161	0.524	+0.278	0.265
Ejection fraction (%)	+0.202	0.421	-0.097	0.703

∗α: Spearman's rank-order correlation was used to assess correlations. P<0.05 was considered statistically significant.
β: Rho is a non-parametric correlation measure.

DISCUSSION

A key finding of this study was a positive correlation between left ventricular end-diastolic volume and stroke volume, as measured by echocardiography, and depression in hemodialysis patients. This finding aligns with previous research demonstrating a link between cardiovascular events and depression (12). Depression and cardiovascular morbidity, both of which negatively impact quality of life, appear to be intertwined and may influence each other. The prevalence of depressive symptoms in our study population was 30-32%, consistent with previous research (13,14). While no significant correlation was found between Beck Depression Inventory (BDI) scores and echocardiographic parameters in the total study population, a positive correlation was observed between BDI score and both left ventricular end-diastolic volume ($r=0.328$, $p=0.047$) and stroke volume ($r=0.371$, $p=0.024$) in the subgroup of hemodialysis patients. No such correlation was found in the peritoneal dialysis subgroup.

Biologically, the primary pathogenesis of depression within the central nervous system is considered to be chronic inflammation (15). This ongoing inflammatory state disrupts the balance of neurotransmitters such as serotonin, dopamine, and noradrenaline in the central nervous system and activates glial cells and astrocytes in the brain, which, in turn, leads to the continuous release of cytokines, perpetuating a depressive mood state (15). A bidirectional relationship exists between cardiovascular diseases (CVD) and depression, with the frequency of depression being more common in individuals with cardiovascular disease than in the general population (16). A meta-analysis that included 38 studies with a total of 63,444 participants reported that the prevalence of depression was 24% and 19% higher in patients with heart failure and coronary artery disease, respectively (17). In contrast, patients with depression are known to have a higher risk of myocardial infarction, stroke, and mortality (18). In cases of depression, increased stress, sympathetic activity, and stress hormones like cortisol enhance inflammation, accelerating the development of hyperlipidemia, hypertension, and atherosclerosis (19, 20). Besides, in patients who have experienced a cardiovascular event, the gut microbiota is disrupted, systemic inflammation increases, and endothelial and hypothalamic-pituitary-adrenal (HPA) axis dysfunction develops, contributing to a depressive mood (21). These same inflammatory and vascular pathways are also central to the pathogenesis of chronic kidney disease. Likewise, a bidirectional relationship exists between chronic kidney disease and depression (22). In chronic kidney disease (CKD), inflammation and the development of microvascular calcification begin, and existing atherosclerosis is accelerated (23). The excretion of uremic toxins is reduced as the glomerular filtration rate decreases; such reduction in uremic toxin excretion disrupts the neurotransmitter balance in the brain, thus initiating a mood disorder and leading to the development of depression (16).

The relationship between volume status and echocardiographic measures, such as left atrial diameter and inferior vena cava diameter, is well recognized. The inferior vena cava collapsibility index decreases in the presence of volume overload (24, 25). Kürşat et al. found that the frequency of depression increased with a decreasing inferior vena cava closure index in hemodialysis patients, suggesting a link between volume status dysregulation and depression (24). Left ventricular concentric and eccentric hypertrophy can also serve as indirect indicators of volume overload (26). Depression is more common in dialysis patients with volume overload studies have shown that patients who are often hypervolemic typically have a diminished perception of their health, are non-adherent to treatment, have impaired nutrition, and are hypoalbuminemic (27). Kim et al. studied 61 hemodialysis patients, administering the BDI three times at five-month intervals. They found that patients with persistent depressive symptoms exhibited a significant increase in left ventricular mass index, left ventricular end-diastolic diameter, left ventricular end-systolic diameter, left ventricular posterior wall thickness, and the E/Em ratio, an indicator of left ventricular filling pressure and diastolic function (28). Similar to previous studies, we observed increased left ventricular end-diastolic volume in hemodialysis patients with depressive symptoms.

Beyond depression, cognitive dysfunction is another critical comorbidity in this population. The prevalence of cognitive dysfunction in end-stage renal disease has been reported to range from 27% to 67% (20). Kurella et al. found a prevalence of 23.6% in peritoneal dialysis patients through the Mini-Mental State Examination (MMSE), a finding similar to the prevalence of cognitive dysfunction in hemodialysis patients (29). In our study, the prevalence of cognitive dysfunction was 27% in the total dialysis population, with 38% in the hemodialysis subgroup and 22% in the peritoneal dialysis subgroup. These findings are consistent with previous research. Our observation that hemodialysis patients exhibited worse cognitive function is likely explained by differences in patient characteristics between the dialysis modalities, as peritoneal dialysis patients tend to be younger, have fewer comorbidities, and have better educational and socioeconomic status.

The pathophysiology of cognitive dysfunction in hemodialysis patients is not fully understood and is influenced by multiple factors (30). Hemodynamic stress, activation of the complement system following contact between blood plasma and the dialysis membrane, immeasurable microbubbles formed during dialysis, and rapid shifts in plasma osmolarity lead to endothelial inflammation, damage, and dysfunction (30-32). This impairs microcirculation, which is regulated by endothelial cells in the tissues, thereby reducing tissue perfusion. Consequently, ischemia develops in the central nervous system, intestinal system, and cardiovascular system (33). Studies using PET-CT and MRI have demonstrated that cerebral blood flow decreases after the initiation of hemodialysis (30, 34). Cerebral ischemia and an increase in brain volume begin almost immediately after the hemodialysis session starts (35). Research has observed that changes in consciousness developing after hemodialysis initiation are associated with this cytotoxic edema (35, 36). Furthermore, cerebrovascular autoregulation has been shown to be more impaired in hemodialysis patients compared to non-dialyzed patients with the same stage of kidney disease (36, 37). On the other hand, in peritoneal dialysis patients, cerebral blood flow does not decrease after the start of dialysis (38). Hypotensive episodes during hemodialysis also contribute to organ hypoperfusion and silent cerebral ischemias, which, over time, can lead to cortical atrophy in patients (33). The accumulation of uremic toxins as the glomerular filtration rate declines also diminishes cognitive functions (39). Additionally, in hemodialysis patients, intestinal ischemia and increased inflammation cause a disruption of the intestinal microbiota, allowing more uremic toxins to enter systemic circulation (39). In summary, the convergence of the factors detailed above leads to cognitive dysfunction in hemodialysis patients.

In peritoneal dialysis patients, however, cognitive functions are better preserved compared to hemodialysis patients, an observation consistent with our study's findings. It is known that cerebral blood flow does not decrease after the initiation of peritoneal dialysis (38). During peritoneal dialysis, hypotensive attacks do not occur, and significant hemodynamic stress and additional endothelial damage are not expected (40). Sudden shifts in plasma osmolarity are also not observed (30). Ischemia does not develop in the intestinal and cardiovascular systems as it does in hemodialysis patients, which contributes to better cognitive outcomes (40). On the other hand, peritoneal dialysis patients also have factors that negatively affect cognitive function. Compared to hemodialysis patients, those on peritoneal dialysis experience greater metabolic stress (41). As a result of exposure to glucose and glucose degradation products in peritoneal solutions, oxidative stress and inflammation increase, leading to vascular damage and a gradual decline in cognitive function over time (30, 41).

Reduced cognitive function is a known complication in patients with heart failure and represents a significant cause of morbidity and mortality (42). The mechanism of cognitive dysfunction that develops in heart failure is similar to that which occurs in chronic kidney disease (43, 44, 45). For instance, in heart failure, cerebral blood flow also decreases, cerebral microemboli and inflammation develop, and sympathetic activity increases. However, cognitive dysfunction in dialysis patients who also have heart failure has not been extensively studied. To address this, our study aimed to investigate the relationship between echocardiographic findings and cognitive functions in

peritoneal dialysis patients, hemodialysis patients, and the entire cohort of dialysis patients. In all groups, we were unable to detect a statistically significant relationship between echocardiographic findings and cognitive functions. This finding was particularly unexpected given that our cohort included patients with both cardiovascular disease and chronic kidney failure—conditions jointly implicated in cognitive decline. However, while surprising in our high-risk population, this null finding is not without precedent in the literature. For instance, research by Eggermont et al. in a healthy population similarly found no correlation between cognitive function and various echocardiographic parameters, including cardiac output, ejection fraction, and left ventricular mass index (46). In contrast, studies focused specifically on patients with chronic kidney disease present a more complex picture. Fomin et al. examined both predialysis and dialysis patients and identified a significant association between left ventricular myocardial hypertrophy and impaired cognitive function (47). This divergence in the literature, coupled with the unexpected result in our own study, underscores that the brain-heart axis in uremia is not fully understood. Therefore, further research with larger sample sizes and longer follow-up periods is needed to explore this relationship in greater detail.

CONCLUSION

Quality of life in patients receiving dialysis is directly associated with morbidity and mortality. Depression and cognitive function are two critical factors influencing quality of life in this population. Besides, cardiovascular events are a leading cause of morbidity and mortality in dialysis patients. It is therefore essential to investigate the relationship between echocardiographic parameters, as indirect indicators of cardiac function, and both depression and cognitive function, which could facilitate the identification of modifiable or reversible factors contributing to reduced quality of life in these patients.

In conclusion, our study demonstrated an association between depression and cardiovascular events in dialysis patients, with left ventricular end-diastolic volume and stroke volume correlating with depression. These findings are consistent with those of similar studies conducted internationally. However, no correlation was found between cognitive function and echocardiographic parameters in our patient cohort. While previous research in dialysis patients has not identified a clear relationship, studies in the general population with cardiovascular disease have demonstrated an association between cognitive function and cardiac events.

Ethics approval

In this study, we undertake that all the rules required to be followed within the scope of the "Higher Education Institutions Scientific Research and Publication Ethics Directive" are complied with, and that none of the actions stated under the heading "Actions against Scientific Research and Publication Ethics" are not carried out. This study was approved by the Research and Publication Ethics Board of the Süleyman Demirel University (74827-31 / 14.02.2018). Each participant provided their consent in the study and was fully informed that they might leave the survey at any time without providing a reason.

Conflict of interest

The authors declare that they have no conflict of interest.

Author contributions

Design of the manuscript: Barış Afşar; Obtaining data for the article: Muammer Avcı, Fatih Aksoy.; Analyzing the data: Muammer Avcı, Ela GÜven Avcı; Drafting the manuscript: Fatih Aksoy.; Critical revision for content: Fatih Aksoy.; Final approval of the version to be published: Ela Güven Avcı, Muammer Avcı.

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