Journal of Medical Case Reports and Reviews

Received 01 May 2020 | Revised 03 May 2020 | Accepted 01 Jul 2020 | Published Online 03 Jul 2020

JMCRR 03 (07), 693-697 (2020) ISSN (O) 2589-8655 | (P) 2589-8647

JMCRR

ASSESSING CARDIAC FUNCTIONS in HEMODIALYSIS PATIENTS USING BY TISSUE DOPPLER IMAGING

Isa Ardahanli[1], Okan Akyuz[2], Recep Demirci[3]

[1]Department of Cardiology, Bilecik State Hospital, Bilecik, Turkey

[2]Department of Nephrology, Bilecik State Hospital, Bilecik, Turkey

[3]Department of Nephrology, Kanuni Sultan Süleymen Training and Research Hospital, Turkey

Article Info

***Corresponding Author:**

Isa Ardahanli

Email: isaardahanli@gmail.com

Abstract

Aim: Heart failure is an important cause of morbidity and mortality in end-stage renal disease patients. It is important to diagnose and take precautions before heart failure develops in this group of patients. We aimed to evaluate diastolic dysfunction, which may be the first stage of heart failure using tissue Doppler imaging (TDI) in hemodialysis (HD) patients.

Methods: The study included 49 patients receiving HD treatment and 46 healthy controls matched for age and sex. Echocardiographic evaluation including tissue Doppler measurements was performed to all participants.

Results: Early diastolic peak (Em) was lower, late diastolic peak (Am) was significantly higher in the HD group ($p < 0.001$ and $p = 0.042$, respectively). Em / Am ratio was statistically lower in the HD group ($p < 0.003$). There was no statistically significant difference in IVCT, ET and MPI between the groups. IVRT was statistically higher in the HD group ($p < 0.001$).

Conclusion: In our study, the frequency of diastolic dysfunction was found to be higher in HD patients compared to the control group by tissue Doppler imaging. We think that the use of TDI to detect diastolic dysfunction at an early stage may be important in this group of patients and may be used for screening.

Introductıon:

Chronic kidney disease (CKD) is defined by the presence of renal damage or decreased renal function for three or more months regardless of the cause (1). CKD is an increasingly important public health problem worldwide. The number of patients enrolled in the hemodialysis program due to end-stage renal disease (ESRD) is gradually increasing (2,3). ESRD patients experience significant morbidity, mortality and poor quality of life (4). Cardiovascular diseases are an important cause of morbidity and mortality in patients receiving dialysis treatment. Cardiovascular events account for more than 40% of deaths of known etiology in ESRD patients (5). Diastolic dysfunction is one of the main characteristics of heart failure with preserved ejection fraction (HFpEF). It is a comprehensive

condition that is responsible for most of the significant heart failure in ESRD patients (6).

Diastolic dysfunction is an early manifestation of CVD which precedes cardiac failure in CKD patients (7,8). Diastolic dysfunction is a more common condition in CKD patients than systolic dysfunction (9). CKD patients are at an approximately three-fold increased risk for severe diastolic dysfunction prevalence compared to the general population (10,11). Diastolic (dis) function is clinically examined especially by echocardiography. Many diastolic function indices have been described in the evaluation (12). Tissue Doppler imaging is one of them.

Many studies have been conducted on the association of heart failure and diastolic dysfunction in HD patients. Most of them were performed by conventional echocardiography methods. However, there were few studies on the evaluation of diastolic dysfunction by tissue Doppler imaging.

This study aimed to evaluate the diastolic dysfunction which is accepted as the early stage of heart failure with tissue Doppler echocardiography in HD patients. We aimed to compare it with the healthy group and test the strength of the diagnostic value at an early stage.

Materıal and Methods:

Study group and study design

This study was designed prospective, cross-sectional and single-center. The study included forty-nine dialysis patients (study group) aged 36-80 years and 46 age-sex matched normal individuals. The study was conducted between August 2018 and November 2018 in Bilecik State Hospital Nephrology Department. Those who read and signed the consent form were included in the study as patient and control groups according to their health status. Local ethics committee approval was obtained.

Exclusion criteria:

Heart failure,

Atrial fibrillation / flutter,

Active infection,

Known history of malignancy,

Chronic lung disease,

Severe anemia,

Patients with a known history of coronary artery disease (CAD), congenital heart disease,

Severe valvular heart disease,

Pregnancy.

General evaluation

Anamnesis was taken from all participants and a complete physical examination was performed. The demographic data of the participants were recorded. Venous blood samples were taken after 12 hours of fasting. Blood count and routine biochemical parameters were measured. Echocardiographic examinations were performed using a Philips brand EPIQ 7 echocardiography device and a 2.5 MHz transducer. The measurements were performed according to the recommendations of the American Echocardiography Society in the left lateral decubitus position (13). For tissue doppler imaging, the device's TDI program was used. Tissue Doppler sample volume was placed on the lateral walls of the mitral annulus in an apical four-chamber view. Respectively, early diastolic peak (Em), late diastolic peak (Am), and systolic flow peak velocities (Sm) were measured in the annulus of the septal and lateral walls. Isovolumetric relaxation time (IVRT), isovolumetric contraction time (IVCT) and ejection times (ET) were recorded. MPI was determined by the following formula; IVRT +IVCT/ ET. The assessments were performed by a cardiologist who did not have access to patient data.

SPSS 20.0 for Windows program was used for statistical analysis. Descriptive statistics were given as mean for numerical variables and median for standard deviation. The student's t-test was used to compare two independent groups when the numerical variables provided the normal distribution condition, and the Mann Whitney U test was used when the normal variables did not meet the normal distribution condition. Since the relationships between numerical variables did not provide parametric test conditions, Spearman Correlation analysis was used. The statistical significance level was accepted as $p < 0.05$.

Results:

Forty-nine patients with HD and 46 healthy individuals who met the study criteria were included. Forty-eight of the participants were female and 47 were male. The mean age was 65 ± 17.8 and the mean body mass index (BMI) was 29 ± 3.1 kg / m^2. Age distribution was similar between the groups. The male participant was more in the HD group. In the control group, the female participant was more ($p < 0.001$). The number of participants with a history of hypertension and diabetes mellitus was significantly higher in the HD group. ($p < 0.001$ and $p < 0.001$, respectively). Demographic properties are shown in Table 1.

Table 1: Baseline characteristics of the participants

	HD group (n=49 (Mean±SD)	Control (n=46) (Mean±SD)	P value
Age	64.4±12.0	63.7±8.9	0.672
Female /male, n (%)	17/32 (34.7/ 65.3)	31/15 (67.4/ 32.6)	**<0.001**
Weight (kg)	65±17.3	66±15	0.264
BMI, kg/ m^2	28.7±3.5	29.2±3.3	0.480
Hypertension, n (%)	17 (34.6)	6 (13)	**<0.001**
Diabetes mellitus, n(%)	22 (44.8)	7 (15.2)	**<0.001**
Heart rate, beats/ min,	80.1 (14.7)	77.5 (9.2)	0.571

BMI: Body Mass Index, SD: Standard Deviation

While the Em velocity and Em / Am ratio were lower in the HD group ($p < 0.001$ and $p = 0.003$, respectively), Am was significantly higher ($p = 0.042$). S wave measured from the lateral wall similar to the groups. IVRT was significantly higher in the HD group ($p < 0.001$). IVCT and ET were higher in the HD group but this difference was not significant ($p = 0.377$ and $p = 0.6$, respectively). Em / Am ratio was statistically significantly lower in the HD group ($p<0.003$). MPI was higher in the HD group. This is not statistically significant ($p = 0.271$). Echocardiographic tissue Doppler measurements are shown in table 2.

Table 2: Tissue Doppler echocardiographic measurements

	HD group (n=49) (Mean±SD)	Control (n=46) (Mean±SD)	P value
LVEF (%)	59.89±2.81	60.04±2,47	0.257
Lateral TDI Em (cm/s)	6.88±2.04	9.96±3.35	**<0.001**
Lateral TDI Am (cm/s)	11.26±2.65	10.16±1.57	**0.042**
Lateral TDI Sm (cm/s)	11.28±4.05	10.64±3.57	0.68
Lateral Em /Am	0.64±0.2	0.98±0.2	**<0.003**
IVCT (ms)	62.79±8.8	58.28 ±12.75	0.377
IVRT (ms)	99.4±14.74	62.41±5.18	**<0.001**
ET (ms)	269.48±23.53	256.36±22.37	0.6
MPI	0.61±0.11	0.47±0.06	0.271

TDI: tissue Doppler imaging; Em: early diastolic velocity; Am: late diastolic velocity; Sm: peak systolic velocity; IVCT: isovolumetric contraction time; IVRT: isovolumetric relaxation time; ET: ejection time; MPI: Myocardial performance index

Discussion:

In our study, we found that Em, Am, S wave velocities and E / A ratio obtained from tissue doppler were in favor of diastolic dysfunction in HD patients. While MPI showing both diastolic and systolic functions of the left ventricle was similar between the groups, we found IVRT significantly higher in the HD group.

Left ventricular filling pressure increases with diastolic dysfunction and is an important mechanism responsible for the pathophysiology of heart failure. The use of Em, Am, S wave velocity and E / A ratio obtained by tissue doppler together with other LV diastolic parameters has been shown to predict mortality in various patient populations (14,15). CKD provides a two-fold increase in the risk of cardiovascular events, and heart failure is the most common cardiovascular event in this population (16). The presence of HF is a predictor of early mortality in dialysis patients as in other patients. Therefore, it was thought that the mortality and morbidity of CKD patients would be reduced by detecting diastolic dysfunction which is seen as the initial stage of HF and taking necessary precautions at an early stage.

Previously, many studies have investigated systolic and diastolic functions in CKD patients. However, the number of studies evaluating diastolic dysfunction with TDI and MPI in ESRD patients is limited. MPI is a parameter in which both systolic and diastolic functions can be evaluated together (17). It is a widely accepted parameter that is not affected by factors such as heart rate and ventricular structure of the preload (18). MPI is an independent risk factor for mortality in acute myocardial infarction (19). Also, MPI has been shown to increase in many autoimmune diseases with cardiac involvement (20, 21). It has been shown that there is a strong correlation between MPI and diseases that play a direct and indirect role in the etiology of heart failure. Erdogan M.A. et al. (22) showed a significant difference in MPI values between ESRD and healthy control groups. In our study, MPI value was high in HD group but this difference was not statistically significant. Another difference in our study was that we evaluated systolic and diastolic dysfunction with the TDI method, which is thought to be more sensitive.

In a study by Jain et al, 1600 patients with a GFR of less than 60% examined a total of 2056 patients. Diastolic dysfunction measured as E / e' was associated with lower GFR. And in all stages of CKD, E / e' has been associated with many negative outcomes, including heart failure and overall mortality (23). Similarly, in our study, diastolic dysfunction was more common in the HD group. The difference in our study was that all patients had ESRD and were treated with HD. In a study evaluating the right heart function in HD patients, E / A ratio was found to be significantly lower in the tricuspid valve in ESRD. In our study, we evaluated left ventricular functions with TDI. We believe that the biventricular functions of HD patients should be evaluated together in large scale studies.

Limitation:

One of the limitations of our study was the relatively low number of study groups and the fact that the study was a single center. Another important limitation was the lack of long-term mortality and morbidity monitoring.

Conclusion:

We found that diastolic dysfunction is more common with tissue Doppler imaging in patients receiving HD treatment for ESRD. Since this method is more sensitive than conventional echocardiographic methods in determining diastolic dysfunction, we thought that it may be useful in early-stage HF screening in HD patients. Also, an important feature of this method is that it is non-invasive, economical, easily applicable, reproducible and widespread.

References:

[1.] Webster AC, Nagler EV, Morton RL, et al. Chronic Kidney Disease. Lancet. 2017;389:1238–52.

[2.] National Kidney Foundation. K/DOQI clinical practice guidelines for chronic kidney disease: evaluation, classification and stratification. Am J Kidney Dis. 2002: 39:S1-S266.

[3.] McClellan WM, Knight DF, Karp H, et al. Early detection and treatment of renal disease in hospitalized diabetic and hypertensive patients: important differences between practice and published guidelines. Am J Kidney Dis. 1997;29:368-375.

[4.] Saran R, Robinson B, Abbott KC, et al. US Renal Data System 2019 Annual Data Report: Epidemiology of Kidney Disease in the United States. Am J Kidney Dis. 2020;75:A6-A7.

[5.] Collins AJ, Foley RN, Chavers B, et al. 'United States Renal Data System 2011 Annual Data Report: Atlas of chronic kidney disease & end-stage renal disease in the United States. Am J Kidney Dis. 2012;59:A7,e1-420.

[6.] Antlanger M, Aschauer S, Kopecky C, et al. Heart Failure with Preserved and Reduced Ejection Fraction in Hemodialysis Patients: Prevalence, Disease Prediction and Prognosis. Kidney Blood Press Res. 2017;42:165-76.

[7.] Bansal N, Roy J, Chen HY, et al. Evolution of Echocardiographic Measures of Cardiac Disease From CKD to ESRD and Risk of All-Cause Mortality: Findings From the CRIC Study. Am J Kidney Dis. 2018;72:390-9.

[8.] Pecoits-Filho R, Bucharles S, Barberato SH. Diastolic heart failure in dialysis patients:

mechanisms, diagnostic approach, and treatment. Semin Dial. 2012;25:35-41.

[9.] Gupta J, Dominic EA, Fink JC, et al. Association between Inflammation and Cardiac Geometry in Chronic Kidney Disease: Findings from the CRIC Study. PLoS One. 2015;10:e0124772.

[10.] Barberato SH, Bucharles SG, Sousa AM, et al. Prevalência e impacto prognóstico da disfunção diastólica na doença renal crônica em hemodiálise [Prevalence and prognostic impact of diastolic dysfunction in patients with chronic kidney disease on hemodialysis]. Arq Bras Cardiol. 2010;94:457-62.

[11.] Bursi F, Weston SA, Redfield MM, et al. Systolic and diastolic heart failure in the community. JAMA. 2006;296:2209-16.

[12.] Nagueh SF, Smiseth OA, Appleton CP, et al. Recommendations for the Evaluation of Left Ventricular Diastolic Function by Echocardiography: An Update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. Eur Heart J Cardiovasc Imaging. 2016;17:1321-60.

[13.] Schiller NB, Shah PM, Crawford M, et al. Recommendation of quantitation of the left ventricle by two-dimensional echocardiography. American Society of Echocardiography Committee on Standards, Subcommittee on Two-Dimensional Echocardiogram. J Am Soc Echocardiogr 1989; 2:358-367.

[14.] Lassen MCH, Sengeløv M, Qasim A, et al. Ratio of Transmitral Early Filling Velocity to Early Diastolic Strain Rate Predicts All-Cause Mortality in Heart Failure with Reduced Ejection Fraction. J Card Fail. 2019;25:877-85.

[15.] Lassen MCH, Biering-Sørensen SR, Olsen FJ, et al. Ratio of transmitral early filling velocity to early diastolic strain rate predicts long-term risk of cardiovascular morbidity and mortality in the general population. Eur Heart J. 2019;40:518-25.

[16.] Tuegel C, Bansal N. Heart failure in patients with kidney disease. Heart. 2017;103:1848-53.

[17.] Tei C, Nishimura RA, Seward JB, Tajik AJ. Noninvasive Doppler-derived myocardial performance index: correlation with simultaneous measurements of cardiac catheterization measurements. J Am Soc Echocardiogr. 1997;10:169-78.

[18.] Karabulut A, Doğan A, Tuzcu AK. Myocardial Performance Index for Patients with Overt and Subclinical Hypothyroidism. Med Sci Monit. 2017;23:2519-26.

[19.] Abaci O, Kocas C, Oktay V, et al. Relationship between myocardial performance index and severity of coronary artery disease in patients with non-ST-segment elevation acute coronary syndrome. Cardiovasc J Afr. 2017;28:4-7.

[20.] Tei C, Dujardin KS, Hodge DO, et al. Doppler index combining systolic and diastolic myocardial performance: clinical value in cardiac amyloidosis. J Am Coll Cardiol. 1996;28:658-64.

[21.] Bruch C, Schmermund A, Marin D, et al. Tei-index in patients with mild-to-moderate congestive heart failure. Eur Heart J. 2000;21:1888-95.

[22.] Erdogan M.A, Ciftci H. Assessment of aortic stiffness, myocardial performance index and cardiac functions in patients with end-stage renal disease. Annals of Medical Research. 25:228-31.

[23.] Jain A, Scott C, Chen HH. The renal-cardiac connection in subjects with preserved ejection fraction: a population based study. ESC Heart Fail. 2017;4:266-273.