

Frequency and type of arrhythmia in Holter electrocardiogram in patients undergoing hemodialysis

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Ethics Committee Approval

This study was approved by the ethics committee of İzmir Bakırçay University non-interventional clinical research with the decision number 2022/769.

All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest

No conflict of interest was declared by the authors.

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Abstract

Background/Aim: It is known that approximately 40% of chronic hemodialysis patients die due to cardiac arrhythmia and cardiovascular diseases. Determining whether the hemodialysis procedure poses a risk for arrhythmia is important in terms of prognostic follow-up of the patients. Therefore, we aimed to determine the underlying arrhythmia frequency and types with 24-hour Holter electrocardiogram (ECG) in patients receiving hemodialysis with normal baseline electrocardiography between the hemodialysis periods.

Methods: Between January 2018 and January 2022, 91 consecutive patients who received hemodialysis for chronic renal failure (CRF) and applied to the cardiology outpatient clinic with complaints of palpitation and sinus rhythm on ECG and evaluated with 24-hour rhythm Holter ECG were included in the study. Our study was designed as a retrospective cohort study.

Results: The mean age of the patient population was 65.78 (11.92) years, the mean systolic blood pressure was 143.71 (24.88) mmHg, and the mean heart rate was 83.43 (15.85) beats/min. Hypertension (HT) (n=44, 48%) and coronary artery disease (n=34, 37%) were the most common comorbid diseases. The most common arrhythmias detected on Holter ECG were ventricular extrasystole (VES) (n=18, 19.8%) and paroxysmal AF (n=8, 8.8%). Non-sustained ventricular tachycardia was detected in two patients.

Conclusion: Detecting arrhythmia in the interdialytic periods in patients receiving hemodialysis due to CRF is important for follow-up and treatment. Even if the baseline ECG is normal in hemodialysis patients with CRF, the frequency of the underlying arrhythmia that needs to be treated is high.

Keywords: arrhythmia, Holter ECG, hemodialysis, frequency

Introduction

Compared to patients with normal renal function, a significant increase in patients undergoing hemodialysis due to end-stage renal disease was observed at a rate of approximately 180/1000 per year (according to the USA renal data system report) [1]. It is known that a high rate of approximately 40% of chronic hemodialysis patients die due to cardiac arrhythmia and cardiovascular diseases [2,3]. The relationship between sudden death and hemodialysis is tried to be explained by the change in serum electrolyte concentrations, which has not been clarified by traditional cardiovascular risk factors alone [4,5].

Many factors in the blood circulation, parathyroid hormone, aldosterone, fibroblast growth factor-23, angiotensin-2, endogenous cardiac glycosides, vitamin D, and angiogenesis inhibitors have been implicated in myocardial fibrosis and reduction of capillary density, but it has not been clarified enough. This pathophysiological process, which results in hypertrophic myocardium and reduced capillary density, can play a critical role in the development of arrhythmia by creating a temporary insufficiency in coronary oxygen delivery [6,7].

Determining whether hemodialysis is linked to arrhythmia in patients with chronic renal failure (CRF) is important for the diagnostic follow-up of patients. Detection and treatment of underlying treatable arrhythmias are effective ways to heal patients and are important in this regard [8–10]. In this respect, we aimed to detect and document arrhythmic events that could not be detected in the basal electrocardiography (ECG) between the hemodialysis periods with 24-hour Holter ECG.

Materials and methods

Patients (n=91) who applied to the cardiology outpatient clinic between January 2018 and January 2022 were receiving hemodialysis for CRF, and were evaluated with 24-hour rhythm Holter ECG were included in the study. Patients whose baseline ECG was not in sinus rhythm and known any arrhythmia, younger than 18 years of age, did not have routine transthoracic echocardiographic (TTE) measurements, and whose rhythm Holter ECG cannot be optimized were excluded from the study. In addition, patients who had malignancy, active infection, prosthetic valve disease, and cardiac pacing were excluded from the analysis.

The results of blood tests, ECG and TTE findings, and rhythm Holter ECG results were obtained from hospital records. The blood analysis results of these patients include the values after hemodialysis, and Holter ECG records were taken from 24-hour rhythm monitoring performed at least one day after receiving hemodialysis.

Our study was designed as retrospective and observational. Before the study, ethical approval was obtained from Izmir Bakırçay University Non-Invasive Clinical Research Ethics Committee. (Decision number: 2022/769).

Definitions

Non-sustained ventricular tachycardia (NSVT) was defined as ventricular-derived tachycardia with a wide QRS complex lasting more than three consecutive beats and lasting less than 30 seconds. Supraventricular tachycardia was defined as atrial origin tachycardia with a narrow QRS complex and

regular RR distance. Paroxysmal AF (Atrial Fibrillation) was defined as atrial origin tachycardia attack with narrow QRS complex and irregular RR distance in rhythm Holter ECG. Multifocal atrial tachycardia (MAT) was defined as three or more different P waves in rhythm Holter ECG, variable P-P, P-R, R-R intervals, and atrial origin tachycardia (atrial rhythm 100–180/min) attack.

Statistical analysis

Analysis was done using the IBM SPSS Statistics 24.0 program. The normality distribution of numerical variables was determined by the Kolmogorov-Smirnov ($n \geq 50$) test. Numerical variables are given as mean and standard deviation. Categorical variables were reported as numbers (n) and percentages (%).

Results

The mean age of the patient population was 65.78 (11.92) (min 41, max 90) years, with a 56% male sex ratio and 44% female sex ratio. The mean body mass index (BMI) was 25.19 (3.64) kg/m². The mean systolic and diastolic blood pressure (BP) of the patients were 143.71 (24.88) mmHg and 82.24 (18.45) mmHg, respectively. The mean heart rate of the patients was 83.43 (15.85) beats/min. 30% of the patients had a history of smoking, and 4% had a history of alcohol use. The clinical and demographic data of the patients are summarized in Table 1.

Table 1: Clinic and demographic data

Variables	Findings, n=91
Age, year, mean (SD)	65.78 (11.92)
Male sex, n (%)	51 (56)
BMI, mean (SD)	25.19 (3.64)
Systolic BP, mmHg, mean (SD)	143.71 (24.88)
Diastolic BP, mmHg, mean (SD)	82.24 (18.45)
Heart rate, beat/min, mean (SD)	83.43 (15.85)
Smoking, n (%)	28 (30)
Alcohol use, n (%)	4 (4)
Hypertension, n (%)	44 (48)
CAD, n (%)	34 (37)
DM, n (%)	24 (26)
Anemia, n (%)	31 (34)
COPD, n (%)	8 (8)
Thyroid disease, n (%)	12 (13)
PTE history, n (%)	5 (5)

BMI: body mass index, BP: blood pressure, CAD: coronary artery disease, DM: diabetes mellitus, COPD: chronic obstructive pulmonary disease, PTE: pulmonary thromboembolism, SD: standard deviation, n: no. of patients

Hypertension (n=44, 48%) and coronary artery disease (n=34, 37%) were the most common comorbid diseases. These were followed by anemia (n=31, 34%), diabetes mellitus (n=24, 26%), thyroid disease (n=12, 13%), and chronic obstructive pulmonary disease (COPD) (n=8, 8%), respectively.

The mean values of blood parameters; hemoglobin 12.54 (2.01) g/dL, fasting glucose 114.54 (40.98) mg/dL, thyroid-stimulating hormone (TSH) 1.45 (1.12) mIU/L and creatinine 2.92 (1.12) mg/dL. The most commonly used drugs by patients before a rhythm Holter ECG were beta-blocker (n=25, 27%), oral iron preparation (n=16, 17%), non-dihydropyridine calcium channel blockers (non-dhp CCBs) (n=12, 13%), and oral vitamin B12 (n=12, 13%). The laboratory findings and drugs used by the patients are given in Table 2.

In echocardiographic findings, the mean left ventricular ejection fraction (LVEF) was n=51.66 (10.71%), and the mean left atrium diameter was 34.74 (4.25) mm. Moderately severe mitral regurgitation was found in 22% of the patients, moderately severe mitral stenosis in 7.7%, moderately severe tricuspid

insufficiency in 20.9%, and moderately severe aortic stenosis in 17.6% of the patients.

Table 2: Laboratory findings and medication of patients

Variables	Findings, (n=91) Mean (SD)
Fasting blood glucose, mg/dL	114.58 (40.98)
Urea, mg/dL	22.33 (13)
Creatinine, mg/dL	2.92 (1.12)
WBC, x 10 ⁹ /L	9.50 (2.44)
Hemoglobin, g/dL	12.54 (2.01)
Platelet, x10 ⁹ /L	254.06 (91.12)
TSH, mIU/L	1.45 (1.12)
Ferritin, ng/mL	52.99 (38.91)
Vitamin B12, pg/mL	261.74 (102.99)
Sodium, mEq/L	138.62 (2.95)
Potassium, mEq/L	4.55 (0.73)
Total cholesterol, mg/dL	208.16 (44.20)
Triglyceride, mg/dL	184.42 (83.78)
HDL, mg/dL	40.80 (9.97)
LDL, mg/dL	123.61 (31.78)
Medications, n(%)	
Betablocker therapy	25 (27)
Non-dihydropyridine CCBs	12 (13)
Oral iron preparation	16 (17)
Oral B12 preparation	12 (13)

WBC: white blood cell, TSH: thyroid stimulant hormone, HDL: high-density lipoprotein, LDL: low-density lipoprotein, CCB: calcium channel blocker, SD: standard deviation, n: no. of patients.

The most common arrhythmias detected on Holter ECG were ventricular extrasystole (VES) (n=18, 19.8%) and paroxysmal AF (n=8, 8.8%). In addition, seven (7.7%) patients had a sustained ventricular tachycardia (SVT) attack, and six (6.6%) patients had supraventricular extrasystole. Non-sustained ventricular tachycardia was detected in two patients. TTE and Holter ECG findings of the patients are presented in Table 3.

Table 3: Echocardiography and Holter ECG findings of the patients

Variables	Findings, (n=91)
LVEF (%), mean (SD)	51.66 (10.71)
Mid-severe mitral regurgitation, n (%)	20 (21.9)
Mid-severe mitral stenosis, n (%)	7 (7.7)
Mid-severe tricuspid regurgitation, n (%)	19 (20.8)
Mid-severe aorta stenosis, n (%)	16 (17.6)
Left atrium diameter, mm, mean (SD)	34.74 (4.25)
VES, n(%)	18 (19.8)
PAF, n(%)	8 (8.8)
SVE, n(%)	6 (6.6)
NSVT, n(%)	2 (2.2)
SVT, n(%)	7 (7.7)
MAT, n(%)	2 (2.2)
AT, n(%)	4 (4.4)

LVEF: left ventricle ejection fraction, VES: ventricular extrasystole, PAF: paroxysmal atrial fibrillation, SVE: supraventricular extrasystole, NSVT: non-sustained ventricular tachycardia, SVT: supraventricular tachycardia, MAT: multifocal atrial tachycardia, AT: atrial tachycardia, SD: standard deviation, n: no. of patients.

Discussion

A 24-hour rhythm Holter ECG scan in patients receiving hemodialysis revealed that arrhythmia was detected in 51% (n=47) of the patients. The most common arrhythmia was VES, followed by paroxysmal AF in 1/5 of the patients.

Ventricular arrhythmias are common in renal failure patients treated with long-term hemodialysis. It is known that the risk of arrhythmia increases during hemodialysis treatment. Ventricular arrhythmias may be responsible for an important component of cardiovascular mortality in hemodialysis patients. Determining the prevalence and types of arrhythmias in dialysis patients is central to reducing cardiovascular morbidity and mortality [11]. The factors predicted for the formation of these arrhythmias in the literature range from hemodynamic changes to metabolic disorders caused by dialysis. It is known that the presence of left ventricular hypertrophy with arterial hypertension, which can occur frequently in renal failure due to volume overload, is a risk factor for the development of complex arrhythmias [11–13].

In a study of 152 patients to estimate the prevalence of arrhythmias and characterize the pattern of arrhythmic events associated with dialysis treatments in patients with renal failure treated with dialysis, early atrial and ventricular complexes were seen in almost all patients, and paroxysmal supraventricular tachycardia was detected in 41%. Clinically significant arrhythmias include persistent AF in 8.6% of patients, paroxysmal atrial fibrillation (PAF) in 3.9%, non-sustained ventricular tachycardia in 19.7%, bradycardia in 4.6%, and 1.3% of patients. Advanced second-degree atrioventricular block was detected in three patients, and third-degree atrioventricular blockes were detected in 2.6% of them. Early ventricular complexes were more common on dialysis days, while tachyarrhythmias were more common during and immediately after dialysis [14]. Because arrhythmias are common during dialysis, this may be one of the limitations of this study. In our study, this situation was avoided by using the interdialytic time interval, and the underlying true arrhythmia frequency and types were investigated in dialysis patients with normal baseline ECG.

In the study of Hamadou et al. [15] investigating the presence of cardiac arrhythmia in chronic hemodialysis patients, VES was observed as the most common arrhythmia, with a rate of 20%. Hypertension, diabetes mellitus, hyperlipidemia, CRF, male gender, and age, which are cardiovascular risk factors, can cause ventricular extrasystoles with their effects on ischemic heart disease [12,13]. The frequency of ventricular arrhythmias in patients with end-stage renal disease is between 13–38%. Bozbaş et al. [16] found the frequency of complex ventricular arrhythmias to be 37.2% in 94 hemodialysis patients. The prevalence of supraventricular arrhythmias is between 16–69% when we look at the [17], and similarly, in our current study, supraventricular arrhythmias other than paroxysmal AF were found to be approximately 20%.

As it is known, hypertension is the most common comorbid disease as a cause or consequence of CRF [18]. In our study, hypertension and coronary artery disease were the most common comorbid diseases.

Although ventricular arrhythmias pose a serious risk for sudden death, atrial arrhythmias, primarily AF, may also result in significant morbidity in patients with CRF receiving hemodialysis. The frequency of AF tends to increase in hemodialysis patients. In a study conducted on elderly dialysis patients, the incidence of AF was found to be 14.8%, and this rate increased from 11% to these levels in the last 15 years [19–21]. Recent studies have shown that arrhythmia is common in the long interdialytic interval, and AF was detected in 42% (86% asymptomatic). This data obtained through ECG monitoring reveals an arrhythmia that is a candidate to cause cerebrovascular events such as AF, even if patients were asymptomatic [22]. In a study investigating the frequency of atrial fibrillation in patients receiving long-term hemodialysis treatment, 183 patients with preserved left ventricular systolic functions and receiving long-term hemodialysis treatment were included. The atrial fibrillation rate was found to be 13.1%. However, in this study, the presence of atrial fibrillation was determined by electrocardiography [23]. In our study, patients with normal baseline ECG were included, and the presence of AF was revealed by a 24-hour Holter. In our

study, PAF was detected in 8.8% of the patients on 24-hour Holter ECGs.

Limitations

Because our study was single-center and retrospective, there were limitations, such as examining the laboratory and imaging tests of the patients from past records. In addition, there were no findings regarding the fluid electrolyte changes during the hemodialysis procedure, the amount of ultrafiltration applied to the patients, or the hemodynamic data during the procedure. Because Holter ECG recordings in our study are limited to 24 hours, more arrhythmia recordings can be detected with longer rhythm recordings.

Conclusion

Detecting arrhythmia in the interdialytic process in patients receiving hemodialysis due to CRF is important for the follow-up and treatment process of the patients. The arrhythmias that can be treated in this patient group is quite frequent. Holter ECG is an important guide in the follow-up of arrhythmias in hemodialysis patients with CRF.

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