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Prevalence and Types of Arrhythmias in Patients with Chronic Kidney Disease on Maintainence Hemodialysis

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ABSTRACT

Background: Patients with chronic kidney disease (CKD) are predisposed to arrhythmia, including atrial fibrillation (AF)/atrial flutter, supraventricular tachycardias, ventricular arrhythmias, and sudden cardiac death (SCD). The aim of this study was to evaluate prevalence and types of arrhythmias and associated clinical characteristics in patients with end stage renal disease on maintainence hemodialysis. **Patients and methods:** This cross-sectional study was conducted on 100 patients with CKD on hemodialysis. 12 leads ECG and Echocardiography were done to all patients. 48-hour Holter monitoring was done if ECG showed no abnormality in the rhythm. **Results**: There was an insignificant correlation between heart rate and potassium, ionized calcium, magnesium, phosphate, PTH, BUN and creatinine. There was a significant negative correlation between heart rate and hemoglobin. There was a significant positive correlation between heart rate and sodium. There was an insignificant correlation between supraventricular arrhythmias and laboratory parameters. There was a significant negative correlation between potassium and atrial fibrillation. Hypernatremia and high Po_4^{-2} and normal PTH were significantly different with SVT. (P value <0.001, 0.011 and 0.009 respectively). **Conclusion**: Hemodialysis may be responsible for the high rate of sudden mortality. Hypertension, coronary artery disease (CAD), and corrected QT interval (QTc) dispersion are independent predictors of complex ventricular Arrhythmia (CVA), and duration of dialysis therapy is an independent factor affecting APC development in these patients.

Keywords: Arrhythmias, Chronic kidney disease, Hemodialysis, coronary artery disease

1. Introduction

Chronic kidney disease (CKD) is defined according to Kidney Disease Improving Global Outcomes (KDIGO) as: kidney damage or glomerular filtration rate (GFR) <60 mL/min/1.73 m^2 for 3 months or more, irrespective of the cause. Kidney damage in many kidney diseases can be ascertained by the presence of albuminuria defined as albumin-to-creatinine ratio >30 mg/g in two of three spot urine specimens (Eknoyan *et al.,* 2004).

Diseases and conditions that cause chronic kidney disease include: Uncontrolled diabetes mellitus, hypertension, glomerulonephritis, Polycystic kidney disease or other inherited kidney diseases, Prolonged obstruction of the urinary tract, from conditions such as enlarged prostate, kidney stones and some cancers, Vesicoureteric reflux and pyelonephritis (Kalantar-Zadeh *et al.,* 2003).

CKD is common among adults in the United States. More than 37 million American adults may have CKD (Teraoka *et al.,* 1995). According to 9th Annual Report of the Egyptian Renal Registry provided by Egyptian Society of Nephrology and Transplantation (ESNT), prevalence of ESRD in Egypt raised to 483 patients per million (Foley *et al.,* 1996). Despite major advances in dialysis technology, mortality is still high in patients with end-stage renal disease (ESRD) (Kalantar-Zadeh *et al.,* 2003).

Mortality in ESRD patients is 10 to 15 times more than it is in age- and sex-matched normal populations (Brown *et al.,* 1994). More than half of all deaths among ESRD patients are due to

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cardiovascular disease (CVD) with arrhythmias, coronary artery disease (CAD), heart failure and sudden cardiac arrest alone is responsible for 38% of deaths (Brown *et al.,* 1994).
Five-year mortality is about 80% in these patients; of these deaths, an important proportion around 18–25% is in the form of sudden death, it is well known that serious ventricular arrhythmia is the cause of many sudden cardiac deaths, and that cardiac arrhythmia is quite common in patients on maintainence dialysis (Sarnak *et al.,* 2003).

Ventricular premature complex (VPC) reportedly occurs in 76–100% of these patients, while complex ventricular arrhythmia (CVA) is found in 13–36% of these patients (Foley *et al.,* 1996). Supraventricular arrhythmia is also common and is observed in 20–88% of ESRD patients.

Three factors are required for lethal cardiac arrhythmia to occur: arrhythmogenic substrate, triggering factors, and changes in the activity of the autonomic nervous system (Foley *et al.,* 1996).
Triggering factors are usually the premature ectopic beats originating from the atria or ventricles. To detect the effects of autonomic system changes on cardiovascular system, heart rate variability (HRV) analysis is widely used (Levin *et al.,* 1999).

This study will investigate the prevalence and the determinant risk factors of cardiac arrhythmia in patients suffering chronic kidney disease on maintenance hemodialysis.

2. Patients and Methods

Type of study

It is a cross-sectional study that was conducted on 100 patients with CKD on hemodialysis recruited from Tanta University Hospitals hemodialysis units. The study started from July 2022 to December 2022.

Criteria of patient selection:

Inclusion criteria:

- CKD patients with ESRD on hemodialysis.
- Adults >18 years.

Exclusion criteria:

- Congenital heart disease.
- Patients with arrhythmias were diagnosed prior to CKD development.

Methods:

All patients were subjected to the followings:

History taking and demographic data collecting:

Age, sex, post-dialysis body weight, height, Body Mass Index (BMI), and smoking.

Medical history and comorbid conditions including:

Hypertension (HTN), diabetes mellitus (DM), coronary artery disease,

Complete clinical examination.

Laboratory tests (Pre-dialysis):

- CBC.
- Electrolytes [Na^{+}, K^{+}, PO_4^{-2}, Mg^{+2}] and Ca^{+2}.
- Arterial blood gases (ABG).
  - pH.
  - $PaCO_2$.
  - HCO_3.
- Blood urea, serum creatinine.
- PTH.
- eGFR- according Cockroft equation.

$$eGFRC{-}G\ (ml/min) = (140 - \text{age in years}) \times (\text{weight in Kg}) \times 1.23 \text{ if male } (1.04 \text{ if female})/SCr \text{ in } \mu mol/L.$$

- Lipid profile [TG, cholesterol, HDL, LDL and VLDL].

1. **Cardiac assessment including:**
   - Electrocardiogram (12 leads ECG) (Fig.).

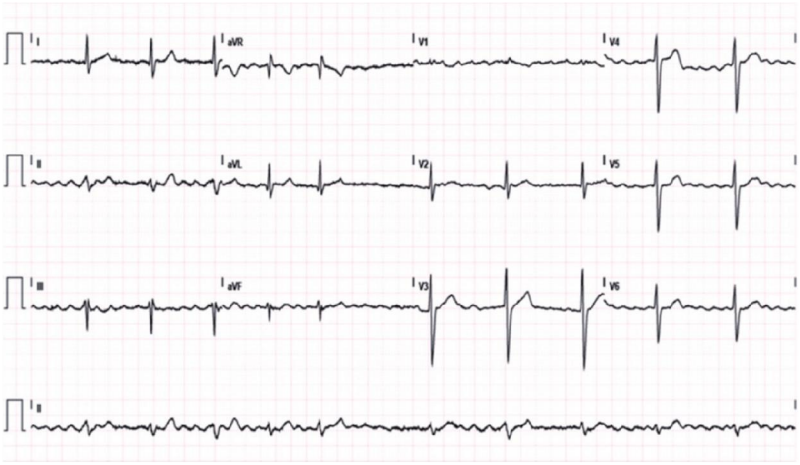

Fig. 1: ECG of AF presentation

- 48-hour Holter monitoring was done if ECG showed no abnormality in the rhythm.
- Echocardiography.

Transthoracic echocardiography assessment:

- left ventricular (LV) diameter.
- Assessment of LV hypertrophy.
- Mitral valve (MV) diseases.
- Tricuspid valve (TV) diseases.
- The presence of pericardial effusion.
- Ejection fraction (%).
-

48-hour Holter monitoring parameters (Fig.):

- **Heart rate:**
  - Mean HR (beats/min).
  - Max. HR (beats/min).
  - Min. HR (beats/min).

-Heart rhythm

Fig. 2: Baseline sinus Rhythm with average HR 75 bpm, Max HR 90 bpm. Minimum HR 50 infrequent PVCS, No sustained tachycardia, No couplets nor triplets, No brachycardia nor pauses.

Holter monitoring device:

Holter devices (CONTEC ™ dynamic ECG system, Model TLC9803) was used to detected arrhythmias of patients with no abnormality detected by ECG consist of a lightweight recorder with a digital memory card and a series of cutaneous electrodes that obtain a continuous ECG recording. They allowed for 48-h monitoring time in most cases (Su *et al.*, 2013).

After completing the recording, it was transferred into software installed on a computer, which usually allowed for an initial automatic analysis identifying the QRS complexes and the R-R interval to offer values such as maximum/minimum rate, histograms of rate or ST segment analysis (Francisco-Pascual *et al.,* 2021).

Dialysis

Dialysis session lasts 4 hr. three times per week. The dialysate contained potassium, 2.0 mmol/L, and glucose, 1 g/L. There were various concentrations of sodium (mean, 138 ± 0.9 [standard deviation] mmol/L), ionized calcium (87%, 1%, and 12% with 1.25, 1.50, and 1.75 mmol/L, respectively), and bicarbonate (35.3 ± 2.4 mmol/L).

Ethical considerations:

1. An informal written consent was taken from all participants after explaining study design, anticipated benefits, and possible risks.
2. We hid the name of the patient when we used the research.
3. The results of the research were used only for scientific purposes and not in any other aims.
4. We used the results of the research only for scientific aim and did not use it in any other aims.
5. Any other unexpected risks that appeared during research were cleared on time to the participants.

Risks to the participants of the study and how to manage:

The investigations were non-invasive and the risk of infection during blood sampling was avoided by complete aseptic techniques. Any other unexplained risks that appeared during the research were cleared on time to the participants and the ethical committee.

Statistical analysis:

Statistical analysis was done by SPSS v26 (IBM Inc., Chicago, IL, USA). Quantitative variables were presented as mean and standard deviation (SD) and compared between the two groups utilizing unpaired Student's t-test. Qualitative variables were presented as frequency and percentage (%) and were analyzed utilizing the Chi-square test or Fisher's exact test when appropriate. Pearson correlation was done to estimate the degree of correlation between two quantitative variables. A two tailed P value < 0.05 was considered statistically significant.

3. Results

Cross sectional stud included 100 patients with chronic kidney disease on hemodialysis recruited from Tanta university Hospitals hemodialysis units. Stared from July 2022 to December 2022.

The mean age value (± SD) of the studied patients was 52.15 (±14.69) years. There were 60% males and 40% females. The mean weight of the studied patients value (± SD) was 78.53 (±11.74) Kg. The mean height of the studied patients value (± SD) was 163.85 (±8.76) cm. The mean BMI of the studied patients value (± SD) was 29.48 (±5.28) Kg/m2. There were 25% smokers and 75% non-smokers (Table 1). .

Regarding comorbid conditions, 51% patients had DM, 92% patients had HTN, 40% patients had coronary heart disease, 29% patients had ischemic stroke, 25%) patients had Peripheral vascular disease, 2% patients had SLE, and 3% patients were malignant. All patients were anemic (Table 2).
Causes of kidney failure were diabetes mellitus in 51% patients, HTN in 20% glomerulonephritis in 8% patients, obstructive nephropathy in 10% patients, polycystic kidney disease in 2% patients and pyelonephritis in 9% patients (Table 3).

Table 1: Demographic data of the studied patients

		N=100
Age (years)	**Mean ± SD**	52.2 ± 14.69
	Range	24 – 70
Sex	**Male**	60 (60%)
	Female	40 (40%)
Weight (Kg)	**Mean ± SD**	78.5 ± 11.74
	Range	60 – 100
Height (cm)	**Mean ± SD**	163.9 ± 8.76
	Range	150 – 180
BMI (Kg/m^2)	**Mean ± SD**	29.5 ± 5.28
	Range	18.94 - 41.44
Smoking	**Smokers**	25 (25%)
	Nonsmokers	75 (75%)

Table 2: Comorbid conditions of the studied patients

	N=100
Diabetes mellitus	51 (51%)
Hypertension	92 (92%)
Coronary artery disease	40 (40%)
Ischemic stroke	29 (29%)
Peripheral vascular disease	25 (25%)
Systemic lupus erythematosus	2 (2%)

Table 3: Causes of kidney failure of the studied patients

	N= 100
Diabetes mellitus	51 (51%)
Hypertension	20 (20%)
Glomerulonephritis	8 (8%)
Obstructive nephropathy	10 (10%)
Polycystic kidney disease	2 (2%)
Pyelonephritis	9 (9%)

Hemoglobin's mean value (± SD) was 9.3 ± 1.13 g/dL. sodium mean value (± SD) was 143.7 ± 6.64mEq/L. Potassium mean value (± SD) was 4.5 ± 0.62mEq/L. Calcium ion patients mean value (± SD) was 1 ± 0.09mEq/L. Magnesium mean value (± SD) was 1.7 ± 0.22. Po_4^{-2}mean value (± SD) was 5.1 ± 1.37mEq/L. PTH mean value (± SD) was 202.5 ± 44.04 pg/mL Urea mean value (± SD) was 68.5 ± 17.86 mg/dL. Creatinine mean value (± SD) was 6.6 ± 2.41mg/Dl (Table 4).

The mean total cholesterol of the studied patients value (± SD) was 194.2 (±6.84) mg/dl. The mean TG value (± SD) was 194.9 (±25.09) mg/dl. The mean HDL value (± SD) was 40 (±7.16) mg/dl. The mean LDL value (± SD) was 101.1 (±23.1) mg/dl. The mean VLDL value (± SD) was 39.7 (±5.3) mg/dl. (Table 5).

pH mean value (± SD) was 7.3 (±0.02). PaCO2 mean value (± SD) was 29.1 (±3.71). HCO_3 mean value (± SD) was 15.2 (±3.04) (Table 6).

The mean total HR of the studied patients value (± SD) was 74.83 (±21.9) beats/min. Type of arrythmia was permanent AF in 13% patients, SVT in 30% patients, HB in 39% patients and 18% patients with no abnormality detected (Table 7).

Table 4: Pre-dialysis laboratory parameters of the studied patients

		N= 100
Hemoglobin (gm/dL)	**Mean ± SD**	9.8 ± 1.13
	Range	7.8 - 11.7
Sodium (mEq/L)	**Mean ± SD**	143.7 ± 6.64
	Range	133 - 155
Potassium (mEq/L)	**Mean ± SD**	4.5 ± 0.62
	Range	3.5 - 5.5
Ionized Calcium (mmol/L)	**Mean ± SD**	1 ± 0.09
	Range	0.8 - 1.13
Magnesium (mEq/L)	**Mean ± SD**	1.7 ± 0.22
	Range	1.4 - 2.1
Po_4^{-2} (mEq/L)	**Mean ± SD**	5.1 ± 1.37
	Range	3 - 7
PTH (pg/mL)	**Mean ± SD**	202.5 ± 44.04
	Range	115.5 - 274.7
Blood urea (mg/dL)	**Mean ± SD**	68.5 ± 17.86
	Range	40 - 100
Creatinine (mg/dL)	**Mean ± SD**	6.6 ± 2.41
	Range	3 – 10

Table 5: Lipid profile of the studied patients

		N=100
Total cholesterol (mg/dL)	**Mean ± SD**	194.2 ± 6.84
	Range	182.6 - 206.1
TG (mg/dl)	**Mean ± SD**	194.9 ± 25.09
	Range	152.4 - 236.2
HDL (mg/dL)	**Mean ± SD**	40 ± 7.16
	Range	27.1 - 52.8
LDL (mg/dL)	**Mean ± SD**	101.1 ± 23.1
	Range	58.7 - 143.7
VLDL (mg/dL)	**Mean ± SD**	39.7 ± 5.3
	Range	31.2 - 49.7

Table 6: ABG of the studied patients

		N=100
pH	**Mean ± SD**	7.4 ± 0.06
	Range	7.32 - 7.52
$PaCO_2$ (mmHg)	**Mean ± SD**	29.1 ± 3.71
	Range	23 - 35
HCO_3 (mEq/L)	**Mean ± SD**	15.2 ± 3.04
	Range	10 - 20

Table 7: ECG of the studied patients

		N=100
Heart rate (beats/min)	**Mean ± SD**	74.8 ± 21.9
	Range	50 - 120
Type of arrhythmia	**Permanent AF**	13 (13%)
	SVT	30 (30%)
	HB	39 (39%)
	No abnormality detected	18 (18%)

Regarding Echo of the studied patients, the ejection fraction mean value (± SD) was 49.6 ± 11.7. LA diameter mean value (± SD) was 4.4 ± 0.72 m. LV dimensions mean value (± SD) was 119.7 ± 23.2 ml/m^2. (Table 8).

50% of patients normally detected by Holter (Basic rhythm is sinus rhythm, no pauses nor blocks, No SVT nor atrial tachycardia and no ventricular tachycardia) (Table 9).

The mean HR value (±SD) was 107.9 (±8.3) beats/min. Supraventricular Arrhythmias was paroxysmal SVT in 22.2% patients and paroxysmal AF in 22.2% patients. Bradycardia (<40 beats/min) was in 22.2% patients, 16.67% patients had infrequent PVCs. 11.11% patients had episodes of bigeminy, 11.11% patients had episodes of trigeminy.

There was an insignificant correlation between heart rate and potassium, ionized calcium, magnesium, phosphate, PTH, BUN and creatinine (Table 10).

There was a significant negative correlation between heart rate and hemoglobin.

There was a significant positive correlation between heart rate and sodium.

There was an insignificant correlation between supraventricular arrhythmias and laboratory parameters (hemoglobin, sodium, potassium, ionized calcium, magnesium, phosphate, PTH, BUN and creatinine) (Table 11).

There was a significant negative correlation between potassium and atrial fibrillation.

There was an insignificant correlation between atrial fibrillation and laboratory parameters (hemoglobin, sodium, ionized calcium, magnesium, phosphate, PTH, BUN and creatinine).

There was an insignificant correlation between ECG and laboratory parameters (hemoglobin, sodium, potassium, ionized calcium, magnesium, phosphate, PTH, BUN and creatinine).

Hypernatremia and high Po_4^{-2} and normal PTH were significantly different with SVT. (P value <0.001,0.011 and 0.009 respectively).

Table 8: Echo of the studied patients

		N=100
LA diameter (m)	**Mean ± SD**	4.4 ± 0.72
	Range	3 - 5.3
LV hypertrophy		42 (42%)
MV diseases	**MR**	90 (90%)
	MS	3 (3%)
TV diseases	**TR**	20 (20%)
	TS	4 (4%)
Pericardial effusion		4 (4%)
Ejection fraction (%)	**Mean ± SD**	49.6 ± 11.7
	Range	30 - 70

Table 9: Arrhythmias detected using 48-hour Holter monitoring of patients with no abnormality detected by ECG

		N=18
Normal N=9 (50%)	Basic rhythm is sinus rhythm	
	No pauses nor blocks	
	No SVT nor atrial tachycardia	
	No ventricular tachycardia	
Findings (50%)	**N=9**	
Mean HR (beats/min)	**Mean ± SD**	107.9 ± 8.3
	Range	94 – 120
Supraventricular Arrhythmias	**Paroxysmal SVT**	2 (22.2%)
	Paroxysmal AF	2 (22.2%)
Brady arrhythmias	**Bradycardia (<40 beats/min)**	2 (22.2%)
	AV block: 2nd-degree, Mobitz I	0 (0%)
	AV block: 2nd-degree, 2:1 block	0 (0%)
	Intermittent AV block: 3rd-degree	0 (0%)
Infrequent PVCs		3 (16.67%)
Episodes of bigeminy		1(11.11%)
Episodes of trigeminy		1(11.11%)

Table 10: Correlations between mean heart rate and pre-dialysis laboratory parameters of the studied patients

		Mean HR (beats/min)
Hemoglobin (gm/dL)	**r**	-.550
	P value	**.018***
Sodium (mEq/L)	**r**	.496
	P value	**.036***
Potassium (mEq/L)	**r**	.235
	P value	.349
Ionized calcium (mmol/L)	**r**	-.440
	P value	.068
Magnesium (mEq/L)	**r**	.012
	P value	.963
Phosphate (mEq/L)	**r**	.303
	P value	.222
PTH (mEq/L)	**r**	-.011
	P value	.966
BUN (mg/dL)	**r**	.137
	P value	.587
Creatinine (mg/dL)	**r**	-.187
	P value	.458

*: significant as P value ≤0.05. r= Pearson correlation.

Table 11: Correlations between tachy- arrythmia and laboratory parameters of the studied patients

		Supraventricular Arrhythmias	Atrial fibrillation
Hemoglobin (g/dL)	**r**	0.894	-0.341
	P value	0.106	0.213
Sodium (mEq/L)	**r**	0.000	-0.160
	P value	1.000	0.568
Potassium (mEq/L)	**r**	-0.447	-0.524
	P value	0.553	**0.045***
Ionized calcium (mEq/L)	**r**	0.447	0.000
	P value	0.553	1.000
Magnesium (mEq/L)	**r**	0.894	0.092
	P value	0.106	0.744
Phosphate (mEq/L)	**r**	0.577	0.187
	P value	0.423	0.505
PTH (mEq/L)	**r**	0.000	0.045
	P value	1.000	0.872
BUN (mg/dL)	**r**	-0.447	0.000
	P value	0.553	1.000
Creatinine (mg/dL)	**r**	0.000	-0.230
	P value	1.000	0.409

4. Discussion

CKD is defined according to KDIGO as: kidney damage or GFR <60 mL/min/1.73 m^2 for 3 months or more, irrespective of cause (Jonsson *et al.,* 2020).

Kidney damage in many kidney diseases can be ascertained by the presence of albuminuria defined as albumin-to-creatinine ratio >30 mg/g in two of three spot urine specimens [(105)].

The high prevalence of CVD among patients undergoing hemodialysis (HD) is a serious problem requiring attention from cardiologists (Erkinovna *et al.,* 2022).

It has been established that a decrease in glomerular filtration rate is associated with increased incidence of CVD and mortality. Patients with CKD are predisposed to heart rhythm disorders, including atrial fibrillation (AF)/atrial flutter, supraventricular tachycardias, ventricular arrhythmias, and SCD. While treatment options, including drug, device, and procedural therapies, are available, their use in the setting of CKD is complex and limited (Mubasher et al., 2020).

This study investigated the prevalence and the determinants of cardiac arrhythmias in patients suffering chronic kidney disease.

Therefore, our study aimed to evaluate prevalence and types of arrhythmias and associated clinical characteristics in patients with end stage renal disease on maintainence hemodialysis.

This cross-sectional study was conducted on 100 patients with chronic kidney disease on hemodialysis recruited from Tanta university Hospitals hemodialysis units.

All the patients in this study were subjected to full history taking, complete clinical examination, laboratory tests, and cardiac assessment.

In this study, the mean age value (± SD) of the studied patients was 52.15 (±14.69) years. There were 60% males and 40% females. The mean post-dialysis weight of the studied patients value (± SD) was 78.53 (±11.74) Kg. The mean height of the studied patients value (± SD) was 163.85 (±8.76) cm. The mean BMI of the studied patients value (± SD) was 29.48 (±5.28) Kg/m^2. There were 25% smokers and 75% non-smokers.

In the same context, Choi *et al.* (2022) conducted prospective observational cohort study on 55 participants with ESRD treated with hemodialysis for at least six months. They found that the mean age was 55.2 ± 10.3 years, with a post-hemodialysis mean weight of the studied patients value was 62.5 ± 12.6 kg. There were 51% males.

Moreover, Likhachev-Mishchenko *et al.* (2022) involved 152 patients with kidney failure to evaluate the prevalence of arrhythmias in patients undergoing chronic hemodialysis, to characterize the arrhythmia types in relation to the dialysis procedure and to determine their relationship with clinical findings and echocardiographic characteristics. They demonstrated that the mean age value (± SD) of the studied patients was 62,2 (±13,8) years. There were 67,8% males. The mean BMI of the studied patients value (± SD) was 27,0 (±6,2) Kg/m^2.

Similar to our results, Bonato *et al.* (2013) carried out cross-sectional study and evaluated 111 chronic kidney disease patients to investigate the prevalence of ventricular arrhythmia and the factors associated with its occurrence in non-dialyzed chronic kidney disease patients. They found that male was 60% of the patients, mean age (years) was 57 ± 11.38, mean BMI (kg/m^2) was 26.8±5.26.

In our study, regarding comorbid conditions, 51% patients had DM, 92% patients had HTN, 40% patients had coronary heart disease, 29% patients had ischemic stroke, 25% patients had peripheral vascular disease, 2% patients had SLE, and 3% patients were malignant (2 patients had multiple myeloma and one patient had cancer colon).

Similar to our results, Choi *et al.* (2022) showed that regarding comorbidity, 53.1% had diabetes, 98.0% had hypertension, 16.3% had coronary artery disease, 2.0% had cerebrovascular accident.

In this regard, Likhachev-Mishchenko *et al.* (2022) reported that 32.2% of the hemodialysis patients had DM, 90,1% of the patients had HTN, 28,9% of the patients had HF, 25% of the patients had coronary artery disease.

In disagreement with our results, Bonato *et al.* (2013) showed that overweight and obesity were found in 32% and 27% of the patients, respectively. Malnutrition was observed in only 4% of the patients according to the subjective global assessment. 24% of the patients had diabetes. Non controlled hypertension was observed in 21% of the patients, while absence of systolic decency in 29%.

In the present study, causes of kidney failure was DM in 51% patients, HTN in 20%, glomerulonephritis in 8% patients, obstructive nephropathy in 10% patients, polycystic kidney disease in 2% patients and pyelonephritis in 9% patients.

In agreement with our results, Choi *et al.* (2022) found that the cause of ESRD was diabetic nephropathy 23 (46.9%), hypertensive 12 (24.5%) glomerulonephritis 11 (22.4%), other 3 (6.1%).

Supporting our results, Likhachev-Mishchenko *et al.* (2022) noted that causes of CKD was DM in 25%, glomerulonephritis in 17,8%, obstructive nephropathy, chronic pyelonephritis in 15,1%, polycystic kidney disease in 11,2%, hypertension or ischemic nephropathy in 9,2%, other or unknown causes in 21,7%.

Similarly, Bonato *et al.* (2013) demonstrated that the main CKD causes were HTN and DM.

Confirming our results, Roberts and Green (2011) reported that diabetes and hypertension each account for a large proportion of arrhythmias in the general population. Both conditions are also responsible for a large proportion of cases of end-stage renal failure

These results were also observed by Bozbas *et al.* (2007) who enrolled ninety-four patients on hemodialysis program and investigated the prevalence and the predictors of arrhythmia in patients on maintainence dialysis. They found that HTN (94.3%) was the most common etiology of ESRD, followed by DM (31.4%) and glomerulonephritis.

In the present study, hemoglobin mean value (± SD) was 9.3 ± 1.13 g/dL. Sodium mean value (± SD) was 143.7 ± 6.64mEq/L. Potassium mean value (± SD) was 4.5 ± 0.62mEq/L. Calcium ion patients' mean value (± SD) was 1 ± 0.09mEq/L. Magnesium mean value (± SD) was 1.7 ± 0.22. Po_4^{-2} mean value (± SD) was 5.1 ± 1.37mEq/L. PTH mean value (± SD) was 202.5 ± 44.04 pg/mL Urea mean value (± SD) was 68.5 ± 17.86 mg/dL. Creatinine mean value (± SD) was 6.6 ± 2.41mg/dL.

Consistent with our results, Choi *et al.* (2022) found that hemoglobin mean value (± SD) was 10.4 ± 1.3 g/dL, ferritin mean value, was 275 ng/mL, albumin mean value was 4.10 g/dL, potassium mean value was 4.58 ± 0.72 mmol/L, total calcium, mean value was 8.96 ± 0.65 mg/dL, Phosphorus mean value was 4.63 ± 1.41 mg/dL. Intact PTH mean value was 206 pg/mL.

Supporting our results, Bonato *et al.* (2013) revealed that creatinine mean value (± SD) was 2.26±0.84 (mg/dL), eGFR (ml/min/1,73 m2) mean value (± SD) was 34.7±16.1, proteinuria was (g/24 h) 0.24 (0–0.79), hemoglobin mean value (± SD) was 12.7±1.8 (g/dL), potassium (mEq/L) was 4.7, magnesium (mEq/L) was 1.9, ionized calcium (mmol/L) was 1.28±0.05, phosphate was 3.78±0.72 (mg/dL), alkaline phosphatase was 81(mg/dl), PTH (pg/ml) was 110, iFGF 23 (pg/ml) 47.3 (23.2–102.8), CRP (mg/dl) was 0.28, IL6 (pg/ml) was 4.6.

In the current study, the mean total cholesterol of the studied patients value (± SD) was 194.2 (±6.84) mg/dl. The mean TG value (± SD) was 194.9 (±25.09) mg/dl. The mean HDL value (± SD) was 40 (±7.16) mg/dl. The mean LDL value (± SD) was 101.1 (±23.1) mg/dl. The mean VLDL value (± SD) was 39.7 (±5.3) mg/dl.

Supporting our results, Bonato *et al.* (2013) revealed that the mean total cholesterol (mg/dL) was 184.2637.7, mean value of LDL cholesterol (mg/dL) 101.6282, mean value of HDL cholesterol (mg/dL) 51.56143, the mean value of triglycerides (mg/dL) was 125.

These results were also observed by Bozbas *et al.* (2007) who found that mean value of total cholesterol (mg/dL) was 177.5 ± 37.9 and the triglycerides (mg/dL) mean value was 179.5 ± 95.7.

In the present study, pH mean value (± SD) was 7.3 (±0.02). PaCO2 mean value (± SD) was 29.1 (±3.71). HCO_3 mean value (± SD) was 15.2 (±3.04).

In the current study, the mean total HR of the studied patients value (± SD) was 74.83 (±21.9) beats/min. Type of arrythmia was permanent atrial fibrillation (AF) in 13% patients, supraventricular tachycardia (SVT) in 30% patients, heart block (HB) in 39% patients and 18% patients with no abnormality detected.

In agreement with our results, Choi *et al.* (2022) found that during the entire inter-dialytic period, there were 583 ventricular ectopy beat (VEs) in 38 patients, 159 ventricular couplets in eight patients, and 35 VTs in four patients. There were 1425 supra ventricular ectopy beat (SVEs) in 48 patients, 307 supraventricular couplets in 38 patients, and 110 SVTs in 22 patients.

These results were also observed by Bozbas *et al.* (2007) who found that the average values of the minimum and maximum heart rates were 68.6 ± 11.9 bpm and 115.6 ± 16.1 bpm, respectively. VPC was detected in 80 (85.1%) patients, and asymptomatic non-sustained monomorphic ventricular tachycardia was noted in three patients (3.1%), two of whom had CAD.

In the current study, regarding Echo of the studied patients, the ejection fraction (EV) mean value (± SD) was 49.6 ± 11.7. LA diameter mean value (± SD) was 4.4 ± 0.72 m.

In agreement with our results, Likhachev-Mishchenko *et al.* (2022) found that the LVEF mean value was 49,7±12,3%, mean LV mass index, g/m^2 was 118,9±51,3, mean LA index >30 ml/m^2 32 (34,4%).

Supporting our results, Bonato *et al.* (2013) revealed that Left ventricular mass index (g/m^2) was 102.3 (84.4–131.3), mean EF (%) was 67 (62–70).

These results were also observed by Bozbas *et al.* (2007) who found that EF (%) was 46.1 ± 10.4.

In the current study, 50% of patients normally detected by Holter (Basic rhythm is sinus rhythm, no pauses nor blocks, No SVT nor atrial tachycardia and no ventricular tachycardia).

In agreement with our results, Likhachev-Mishchenko *et al.* (2022) found that during the Holter ECG recording, 5 (3,3%) patients experienced a chest pain and 2 (1,3%) had syncope of non-cardiac origin, while 5 patients (3,3%) had symptomatic intradialytic hypotension. However, none of these conditions was accompanied by clinically significant arrhythmia.

In the current study, the mean HR value (±SD) was 107.9 (±8.3) beats/min. Supraventricular arrhythmias was paroxysmal SVT in 22.2% patients and paroxysmal AF in 22.2% patients. Bradycardia (<40 beats/min) was in 22.2% patients, 16.67% patients had infrequent PVCs. 11.11% patients had episodes of bigeminy, 11.11% patients had episodes of trigeminy.

In agreement with our results, Likhachev-Mishchenko *et al.* (2022) found that SPBs and PVCs were observed in almost all patients. Complex ventricular arrhythmias (Lown class III III V) were observed in 119 (78,3%) patients. Permanent AF was present in 13 (8,6%) patients, and AF episodes were found in 6 (3,9%) patients. the number of AF episodes ranged from 1 to 14 per day, with a maximum duration of each episode ranging from 37 to 861 minutes in individual patients. In 5 patients, the first recorded AF episode occurred during a dialysis session. A greater number of VT episodes were registered on the dialysis day. Asymptomatic brady arrhythmias were observed in 10 patients. Two patients had episodes of third-degree AV block during dialysis and 2 patients at night.

Supporting our results, Bonato *et al.* (2013) revealed that ventricular arrhythmia was found in 39 patients (35%), from which 19 had also supraventricular arrhythmia. The median number of extra systoles in the population with ventricular arrhythmia was 51 (6–239) events/24 h.

These results were also observed by Bozbas *et al.* (2007) who demonstrated that both ventricular and supraventricular arrhythmias are common in ESRD patients who are on hemodialysis treatment. Ventricular premature contractions were detected in 80 (85.1%) patients, of whom 35 (37.2%) were classified as CVA. Coronary artery disease, hypertension, and QTc dispersion appeared as independent factors predictive of CVA development. APC were detected in 53 patients (56.4%) and supraventricular arrhythmia in 15 (16%) patients; all were identified as atrial fibrillation.

In the current study, there was an insignificant correlation between heart rate and potassium, ionized calcium, magnesium, phosphate, PTH, BUN and creatinine.

In contrary, Lin *et al.,* (2018) reported that high level of serum potassium (hyperkalemia) might potentially result in life-threatening complications by changing the action potential of heart rhythm cells and further inducing critical cardiac arrhythmia.

Further, Bonato *et al.,* (2013) reported that PTH levels were lower in patients with ventricular arrhythmias.

In the current study, there was a significant negative correlation between heart rate and hemoglobin.

Supporting our results, Bonato *et al.* (2013) revealed that in the stepwise logistic regression analysis, hemoglobin, and ejection fraction were the factors independently associated with the presence of ventricular arrhythmia in non-dialyzed CKD patients. Also, there was a negative correlation between heart rate and hemoglobin.

In the current study, there was a significant positive correlation between heart rate and sodium.

In agreement with our results, Likhachev-Mishchenko *et al.* (2022) found that in patients on chronic hemodialysis, older age, increased preload and lower cardiac output are independently associated with clinically relevant arrhythmias. In addition, a positive association between increased LV mass index and AF episodes has been demonstrated. Lower cardiac output had positive correlation with AF and ventricular arrhythmias.

In contrary, Graudal *et al.,* (2016) reduced sodium levels may contribute to increased heart rate.

In the current study, there was an insignificant correlation between supraventricular arrhythmias and laboratory parameters (hemoglobin, sodium, potassium, ionized calcium, magnesium, phosphate, PTH, BUN and creatinine).

Contrasted to our results, Choi *et al.,* (2022) reported that during the long interdialytic interval, the electrolytes such as potassium, and uremic toxins, could directly influence heart function or indirectly affect autonomic function with related increases in arrhythmia.

In the current study, there was a significant negative correlation between potassium and atrial fibrillation.

In agreement with our results, Amit *et al.* (2010) found that there was significant negative correlation between potassium and atrial fibrillation.

In our study, there was an insignificant correlation between atrial fibrillation and laboratory parameters (hemoglobin, sodium, ionized calcium, magnesium, phosphate, PTH, BUN and creatinine).

A study performed by Krijthe *et al.* (2013) reported different results regarding the relationship between serum electrolyte levels and the incidence of atrial fibrillation showed that patients with hypokalemia have a higher risk of atrial fibrillation, and serum potassium levels are associated with an increased risk of atrial fibrillation.

In the current study, there was an insignificant correlation between ECG and laboratory parameters (hemoglobin, sodium, potassium, ionized calcium, magnesium, phosphate, PTH, BUN and creatinine).

Different results obtained by Gv *et al.* (2014) who found that there was a strong negative correlation between Hb level and tachycardia and ECG changes.

Further, El-Sherif and Gioia (2011) demonstrated different results as there was a correlation between the severity of electrolyte impalance and the visible ECG changes.

In the current study, hypernatremia and high Po_4^{-2} and normal PTH were significantly different with SVT. (P value <0.001,0.011 and 0.009 respectively).

Supporting our results, Rafaqat *et al.* (2022) showed that for years in clinical medicines, to stop or treat arrhythmias, electrolytes and magnesium supplements play their role by preventing atrial fibrillation following cardiac surgery, refractory ventricular fibrillation, acute treatment of rapid AF, new-onset and treatment-refractory SVT, and magnesium has been incorporating into their recent guidelines for managing as well as preventing certain arrhythmias.

5. Conclusion

Arrhythmia is frequently observed in ESRD patients receiving hemodialysis may be responsible for the high rate of sudden mortality. Hypertension, Coronary artery disease (CAD), and corrected QT interval (QTc) dispersion are independent predictors of complex ventricular Arrhythmia (CVA), and duration of dialysis therapy is an independent factor affecting APC development in these patients.

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