Acute cardiovascular complications of hemodialysis in patient with end-stage renal disease - a single center experience

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Abstract

Hemodialysis (HD) is an important modality of renal replacement therapy and during HD, patients are at greater risk of cardiovascular complication compared with the general population, with estimated risk is as high as (8 to 20) fold. Most important cardiovascular complications during hemodialysis include; hypotension, arrhythmias, myocardial ischemia and heart failure. The aim of study is to evaluate patient on hemodialysis for occurrence of cardiovascular complication. One hundred patients on hemodialysis were enrolled in this study. Patients were evaluated for cardiovascular complication when they were undergoing hemodialysis through physical examination, electrocardiogram and echocardiography during their admission in hemodialysis unit. The age of the patients enrolled ranged from 30 to 75 years. The mean BMI was ranging from 19 to 29 kg/m2. In this study cardiovascular complications encountered are hypotension (the most frequent complication reported), followed by ventricular ectopic, angina, AF, SVT, LV dysfunction, peripheral vascular disease, AMI and stroke. Hypotension was significantly more in patients with UF >500 ml. Angina and PVD were significantly associated with graft type of venous access. Inconclusion: Hypotension was the most commonly reported cardiovascular complication of hemodialysis in patients who has had a high ultrafiltration rate; presence of other common comorbidity like diabetic mellitus, hypertension, and smoking increase the risk of angina, arrhythmia and infarction.

Key words: Hemodialysis; Cardiovascular complication; End-stage renal disease

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Introduction

Chronic kidney disease (CKD) is global health problem with different manifestations according to its cause and severity. It is defined as presence of decreased kidney function (estimated Glomerular filtration rate (eGFR) <60 ml/min/1.7m2) OR kidney damage (abnormal urinalysis or imaging study) for three months or more [1, 2, 3 ,4, 5, 6]. Glomerular

filtration rate (GFR) is the rate at which fluid passes into nephrons after filtration and is a measure of renal function, while albuminuria reflects increased glomerular permeability to macromolecules [7, 8, 9 10 ,11]. These individuals have a significantly increased risk for all-cause and cardiovascular mortality, [12, 13, 14, 15]. Classification of chronic kidney disease depends on eGFR and albuminuria - according to Kidney Disease Improving Global Outcomes (KDIGO) guidelines as follows: [16, 17, 18, 19, 20].

eGFR staging:

- G1: >90 mL/min/1.73 m^2
- G2: 60-89 mL/min/1.73 m^2
- G3a: 45-59 mL/min/1.73 m^2
- G3b: 30-44 mL/min/1.73 m^2
- G4: 15-29 mL/min/1.73 m^2
- G5: <15 mL/min/1.73 m^2

Albuminuria staging :

- A1: < 30 mg/day
- A2: 30-300 mg/day
- A3: >300 mg/day

Risk factors for chronic kidney disease include diabetes, hypertension, cardiovascular disease, metabolic syndrome, smoking and many others [21, 22, 23, 24]. Screening for CKD should include urinalysis, GFR estimation and renal ultrasonography. Complications of CKD include progression to kidney failure, fluid and electrolyte imbalance, and other to hormonal or systemic dysfunctions, such as development of cardiovascular disease. Management of chronic kidney disease involves treatment of reversible causes, preventing or slowing its progression, treatment of the complications and preparation of the patient in whom renal replacement therapy will be required [25 26, 27, 28]. Renal replacement therapy includes dialysis (hemodialysis or peritoneal dialysis), hemofiltration, and hemodiafiltration and kidney transplantation. Hemodialysis (HD) refers to a process by which a solute passively diffuses down its concentration gradient from one fluid compartment (blood or dialysate) into the other through a semipermeable membrane to produce desired changes in the plasma concentrations of these solutes. Dialysis does not correct the endocrine abnormalities of renal failure nor prevent cardiovascular complications [29, 30] .Dialysis is indicated in severe acidosis , electrolyte changes or fluid overload resistant to medical treatment; or other profound uremic complication (such as pericarditis, pleuritis, nausea and vomiting, bleeding diathesis and uremic encephalopathy) [31,32,33]. Hemodialysis may cause many cardiovascular complications. Sudden and symptomatic fall in BP during a dialysis session is called intradialytic hypotension (IDH). Hemodialysis patients are also particularly susceptible to myocardial ischemia, left ventricular hypertrophy, reduced peripheral arterial compliance, impaired microcirculation and ineffective vaso-regulation. Ventricular and Supraventricular arrhythmias are common during dialysis [30, 34, 35, 36, 37, 38] Records

from the United States Renal Data System (USRDS) have shown that hemodialysis is an independent risk factor for the development of acute heart failure [39]. A significant percentage of cardiac mortality is due to sudden death, and sudden death appears to be temporally related to the dialysis procedure [40].

Patients and Methods

Study design and Subjects

This study was a cross sectional descriptive study conducted in the period between February 2015 through April 2016. The study population comprised of 100 subjects recruited from hemodialysis unit in Al-Sadr Medical City in Najaf, Iraq. In this study, patients with chronic kidney disease on hemodialysis were evaluated for acute cardiovascular complication during and few days after hemodialysis.

Patients selection

- Inclusion criteria: All patients had chronic kidney disease on hemodialysis.
- Exclusion criteria: Patients with history of heart failure, myocardial infarction, angina, arrhythmia and stroke before starting the dialysis are excluded from study. Information about this study and investigations was explained to all patients in this study and verbal consent was obtained prior to enrolment of subjects. Questionnaire is directed to ensuring that the participant meets all the inclusion criteria, socio-demographic characteristics of the subjects, duration of chronic kidney disease, duration of hemodialysis, duration and number and type of vascular access of hemodialysis session. The socio-demographic characteristics of the study patients are outlined in table 1.

Clinical Examination and investigations:

- Height and weight measurement

Height and weight are measured using a well calibrated scale. The weight is recorded in kilogram (Kg). The height was taken to the level of scalp and recorded in centimeter. Body mass index (BMI) was calculated according to the following equation:

$$BMI=\text{Weight (Kg)}/ (\text{Height (m)})^2$$

- Arterial blood pressure measurement

A manual sphygmomanometer is used for blood pressure measurement for all subjects. Measurement was taken four times in the sitting position. The first one was taken 10 minutes after rest and before hemodialysis session, and the second measurement at the beginning of hemodialysis session and the next two measurements one-hour interval.

- Resting electrocardiography (ECG)

Resting ECG was performed in all the patients using CARDIMAX device. Tracing from 12 standard leads was recorded with a chart speed of 50 mm/s. ECG was performed after

hemodialysis. In analysis of ECG, attention was paid to the presence of myocardial infarction, myocardial ischemia, arrhythmia, and pulmonary embolism.

- A transthoracic echocardiography

A transthoracic echocardiography was done in the echo unit in Al-Sadr Medical City in Najaf, Iraq, for the evaluation for left ventricular dysfunction.

- Collection of blood samples

The timing of blood aspiration was before hemodialysis session. Five ml of venous blood were collected from each participant. An aseptic procedure was done in blood aspiration. Blood sample send for:

- Hemoglobin level
- Serum potassium
- serum sodium

Statistical analysis

Data were entered and analyzed using the statistical package for social sciences (SPSS) version 22, IBM, Chicago, US 2013. Descriptive statistics were expressed as mean, standard deviation, frequencies (No.) and proportions (%). Student's t test (independent) was used to compare two means of continuous variables across each complication. Chi square test was used to assess the significance of the relationship between complications and other variables; Fisher's exact test was used as an alternative when Chi square was inapplicable. Level of significance, set at ≤ 0.05, to be considered as significant difference or relationship. Finally, results presented in tables and figures with an explanatory paragraph for each using Microsoft office word 2010.

Results

One hundred patients had been enrolled in this study with a mean age of 52.7 ± 11.6 (range: 30 – 75) years. Thirty-five were males and 65 were females. The mean body mass index (BMI) was 24 ± 2.2 (range: 19 – 29) kg/m2, and 61% of the patients had a BMI within the normal range while 39% were overweight. Current smokers, Hypertensive and diabetic patients were 18%, 38% and 29%, respectively. Table-1 illustrates the socio-demographic features and some risk factors for cardiovascular system.

Table 1.

Socio-demographic characteristics of the studied group (*N*=100*)*

Variable		No.	%
Age (year)	≤ 40	16	16.0
	41 – 50	29	29.0
	51 – 60	27	27.0
	61 -70	20	20.0
	> 70	8	8.0
	mean ± SD	52.7 ± 11.6	-
	range	30 - 75	-
Gender	Male	35	35.0
	Female	65	65.0
BMI (kg/m2)	Normal	61	61.0
	Overweight	39	39.0
	mean ± SD	24 ± 2.2	-
	range	19 - 29	-
Current smoker		18	18.0
Hypertension		38	38.0
Diabetes Mellitus		29	29.0

The frequency of cardiovascular complications in patients on hemodialysis.

As it shown in (Table 2 & Fig. 1); hypotension was the more frequent complication reported among the studied group, (17%), followed by Ventricular ectopic (8%), Angina, AF and SVT, (7%) for each, LV dysfunction (4%), Peripheral vascular disease PVD in (4%), and AMI and stroke in 2% for each.

Table 2.

Distribution of cardiovascular complications among patient on HD (*N*=100)

Complication	No.	%
Hypotension	17	17.0
Ventricular ectopic	8	8.0
Angina	7	7.0
AF	7	7.0
SVT	7	7.0
LV dysfunction	4	4.0
Peripheral vascular disease PVD	4	4.0
AMI	2	2.0
Stroke	2	2.0
Total complication*	39	39.0

There was a statistically significant association between angina and higher age group. Angina was more frequent in patients aged ≥ 50 years, (11.5%) while none of the patients

aged < 50 years had angina, (P = 0.028), other complications showed no statistically significant differences across the age groups, in all comparison, (P > 0.05), (Table 3 & Fig 2).

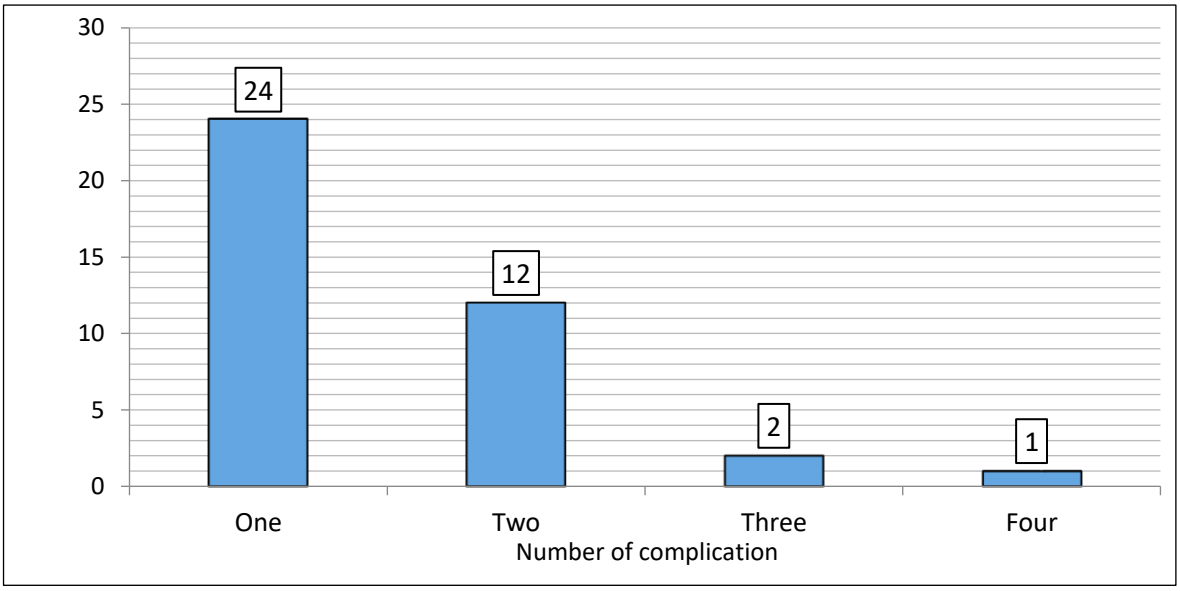

Figure 1.

Distribution of patients according to the number of complications they did have.

Table 3.

Relationship between cardiovascular complications and age of patient on HD (*N*=100)

Complication		Age (year)				P value
		< 50 (n=39)		≥50 (n=61)		
		No.	%	No.	%	
Hypotension	Yes	5	12.8	12	19.7	0.37
	No	34	87.2	49	80.3	
Angina	Yes	0	0.0	7	11.5	**0.028**
	No	39	100.0	54	88.5	
LV dysfunction	Yes	2	5.1	2	3.3	0.64
	No	37	94.9	59	96.7	
AMI	Yes	0	0.0	2	3.3	0.25
	No	39	100.0	59	96.7	
AF	Yes	2	5.1	5	8.2	0.56
	No	37	94.9	56	91.8	
Ventricular ectopic	Yes	1	2.6	7	11.5	0.11
	No	38	97.4	54	88.5	
SVT	Yes	2	5.1	5	8.2	0.56
	No	37	94.9	56	91.8	
Stroke	Yes	0	0.0	2	3.3	0.25
	No	39	100.0	59	96.7	
Peripheral vascular disease	Yes	0	0.0	4	6.6	0.10
	No	39	100.0	57	93.4	

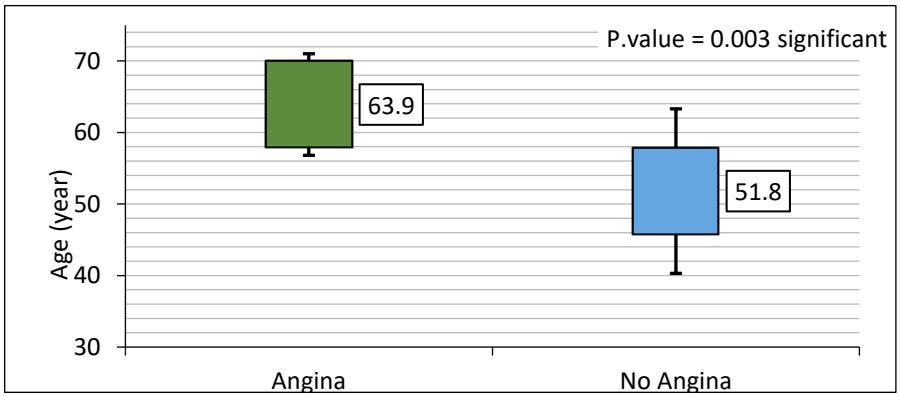

Figure 2.

Comparison of mean age of patients with and without angina

The relation between gender and cardiovascular complications of hemodialysis

No statistically significant differences had been found between genders regarding the cardiovascular complications in patient with CKD on HD (P value >0.05), (Table 4).

Table 4.

Relationship between HD cardiovascular complications and patient gender (*N*=100)

Complication		Gender				P value
		Male (*n*=35)		Female (*n*=65)		
		No.	%	No.	%	
Hypotension	Yes	4	11.4	13	20.0	0.28
	No	31	88.6	52	80.0	
angina	Yes	2	5.7	5	7.7	0.71
	No	33	94.3	60	92.3	
LV dysfunction	Yes	1	2.9	3	4.6	0.67
	No	34	97.1	62	95.4	
AMI	Yes	1	2.9	1	1.5	0.65
	No	34	97.1	64	98.5	
AF	Yes	1	2.9	6	9.2	0.23
	No	34	97.1	59	90.8	
Ventricular ectopic	Yes	3	8.6	5	7.7	0.88
	No	32	91.4	60	92.3	
SVT	Yes	3	8.6	4	6.2	0.65
	No	32	91.4	61	93.8	
Stroke	Yes	1	2.9	1	1.5	0.65
	No	34	97.1	64	98.5	
Peripheral vascular disease	Yes	2	5.7	2	3.1	0.52
	No	33	94.3	63	96.9	

The relation between BMI of the patient and cardiovascular complications of HD

There was no significant effect of BMI on the prevalence of cardiovascular complications in patient with CKD on HD (P value >0.05), (Table 5).

Table 5.

Relationship between BMI of patient and cardiovascular complications of HD (*N*=100)

Complication		BMI (kg/m^2)				P value
		< 25(n=61)		≥ 25(n=39)		
Hypotension	Yes	11	18.0	6	15.4	0.73
	No	50	82.0	33	84.6	
Angina	Yes	3	4.9	4	10.3	0.31
	No	58	95.1	35	89.7	
LV dysfunction	Yes	3	4.9	1	2.6	0.56
	No	58	95.1	38	97.4	
AMI	Yes	1	1.6	1	2.6	0.75
	No	60	98.4	38	97.4	
AF	Yes	5	8.2	2	5.1	0.56
	No	56	91.8	37	94.9	
Ventricular ectopic	Yes	4	6.6	4	10.3	0.51
	No	57	93.4	35	89.7	
SVT	Yes	5	8.2	2	5.1	0.56
	No	56	91.8	37	94.9	
Stroke	Yes	1	1.6	1	2.6	0.75
	No	60	98.4	38	97.4	
PVD	Yes	2	3.3	2	5.1	0.65
	No	59	96.7	37	94.9	

The relation between duration of hemodialysis treatment and cardiovascular complications of HD

There are no significant relation between mean duration of HD and development of cardiovascular complications in patient with CKD on HD except for Peripheral vascular disease (PVD), (P value > 0.05), except in the patients with Peripheral vascular disease who had significantly longer duration on HD than those without Peripheral vascular disease, (7.1 ± 3.7) vs. (3.2 ± 2.1), respectively, (P = 0.004), (Table 6 & Fig 3).

Table 6.

Relationship between cardiovascular complications and Duration of HD patient (*N*=100)

Complication		Duration on HD (months)		P value
		Mean	SD	
Hypotension	Yes	3.8	2.4	0.47
	No	3.2	2.8	
Angina	Yes	4.5	3.6	0.22
	No	3.2	2.6	
LV dysfunction	Yes	2.0	2.0	0.33
	No	3.4	2.7	
AMI	Yes	2.0	1.4	0.49
	No	3.3	2.7	
AF	Yes	3.9	2.9	0.62
	No	3.3	2.7	
Ventricular ectopic	Yes	2.9	3.4	0.71
	No	3.4	2.7	
SVT	Yes	3.9	2.7	0.60
	No	3.3	2.7	
Stroke	Yes	5.5	6.4	0.71
	No	3.3	2.6	
Peripheral vascular disease	Yes	7.1	3.6	**0.004**
	No	3.2	2.3	

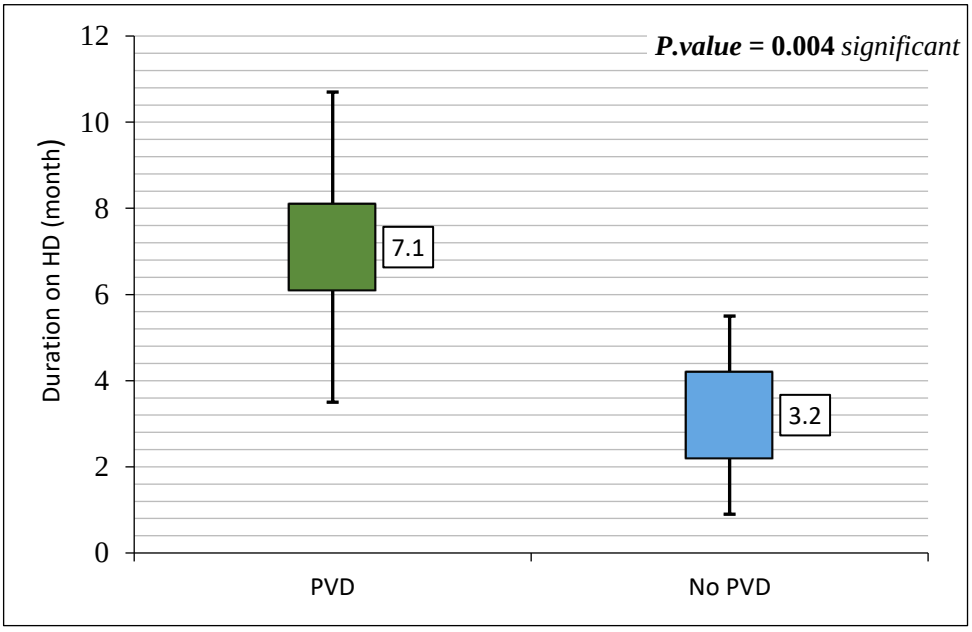

Figure 3.

Comparison of mean duration on HD between patients with and without PVD.

There was a statistically significant association between ultrafiltration rate and hypotension, (P > 0.05), where hypotension was more frequent in patients who had UF rate >500, (64.7%) while in UF rate ≤ 500 was (35.5%), other complications showed no statistically significant association (Table 7 and Fig. 4).

Table 7.

Relationship between cardiovascular complications and Ultra filtration rate in patient on HD (*N*=100)

Complication		Ultra-filtration				P value
		≤ 500(n=64)		> 500 (n=36)		
		No.	%	No.	%	
Hypotension	Yes	6	9.4	11	30.6	**0.007**
	No	58	90.6	25	69.4	
Angina	Yes	6	9.4	1	2.8	0.22
	No	58	90.6	35	97.2	
LV dysfunction	Yes	3	4.7	1	2.8	0.64
	No	61	95.3	35	97.2	
AMI	Yes	1	1.6	1	2.8	0.68
	No	63	98.4	35	97.2	
AF	Yes	3	4.7	4	11.1	0.23
	No	61	95.3	32	88.9	
Ventricular ectopic	Yes	5	7.8	3	8.3	0.93
	No	59	92.2	33	91.7	
SVT	Yes	3	4.7	4	11.1	0.23
	No	61	95.3	32	88.9	
Stroke	Yes	1	1.6	1	2.8	0.68
	No	63	98.4	35	97.2	
PVD	Yes	3	4.7	1	2.8	0.64
	No	61	95.3	35	97.2	

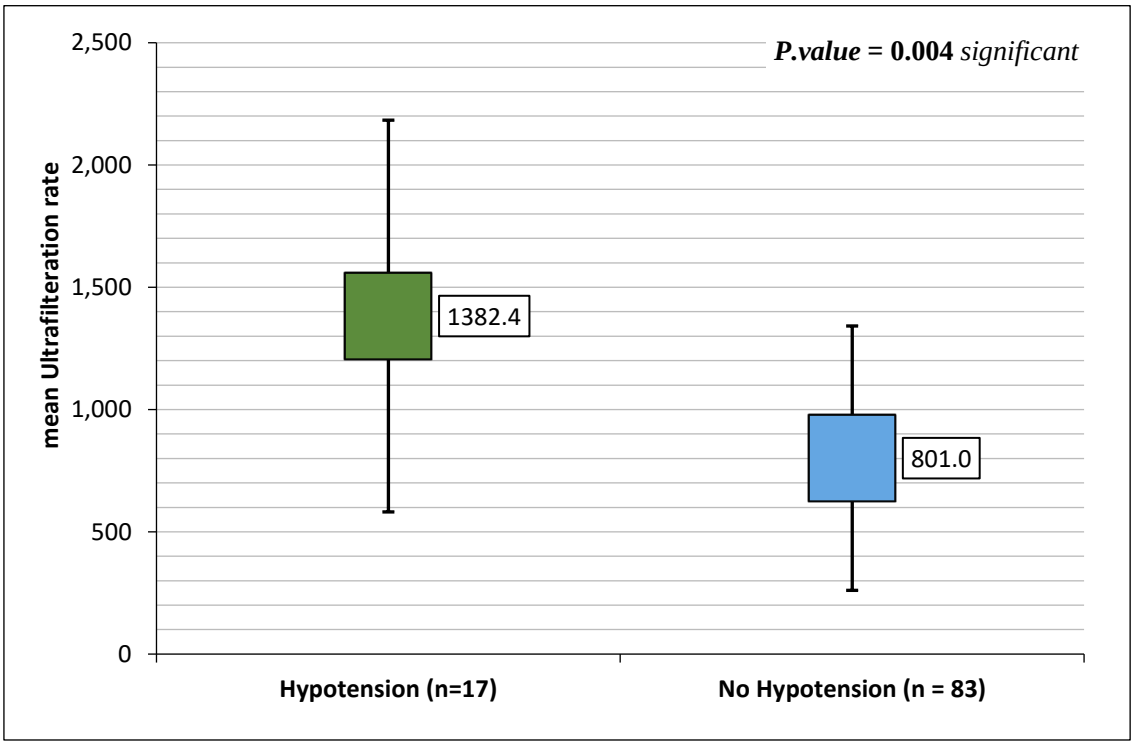

Figure 4.

The relation between mean Ultrafiltration rates of HD and hypotension in patients on HD

The relation between the type of vascular access and cardiovascular complications of HD

From other point of view, angina and PVD were more frequent in patients who dialyse through central venous catheter (double lumen catheter) versus other vascular accesses, (P< 0.05), (Table 8).

Table 8.

Relationship between cardiovascular complications and type of vascular access in HD patient (*N*=100)

Complication		V-access						P value
		Dual lumen(*n*=68)		AV fistula(*n*=24)		Graft(*n*=8)		
		No.	%	No.	%	No.	%	
Hypotension	Yes	8	11.8	6	25.0	3	37.5	0.091
	No	60	88.2	18	75.0	5	62.5	
Angina	Yes	3	4.4	1	4.2	**3**	**37.5**	**0.002**
	No	65	95.6	23	95.8	5	62.5	
LV dysfunction	Yes	3	4.4	1	4.2	0	0.0	0.83
	No	65	95.6	23	95.8	8	100.0	
AMI	Yes	2	2.9	0	0.0	0	0.0	0.62
	No	66	97.1	24	100.0	8	100.0	
AF	Yes	3	4.4	4	16.7	0	0.0	0.093
	No	65	95.6	20	83.3	8	100.0	
Ventricular ectopic	Yes	5	7.4	1	4.2	2	25.0	0.16
	No	63	92.6	23	95.8	6	75.0	
SVT	Yes	5	7.4	1	4.2	1	12.5	0.71
	No	63	92.6	23	95.8	7	87.5	
Stroke	Yes	1	1.5	1	4.2	0	0.0	0.66
	No	67	98.5	23	95.8	8	100.0	
PVD	Yes	0	0.0	2	8.3	**2**	**25.0**	**0.001**
	No	68	100.0	22	91.7	6	75.0	

The relation between hemoglobin level of patients and cardiovascular complications of HD

No significant association had been found between cardiovascular complications of HD and with Hemoglobin levels in patient with CKD on HD (Table 9).

Table 9.

Relationship between cardiovascular complications and Hemoglobin level in HD patient (*N*=100)

Complication		Hemoglobin (g/dL)				P value
		<8(n=81)		≥ 8(n=19)		
		No.	%	No.	%	
Hypotension	Yes	13	16.0	4	21.1	0.6
	No	68	84.0	15	78.9	
Angina	Yes	5	6.2	2	10.5	0.5
	No	76	93.8	17	89.5	
LV dysfunction	Yes	4	4.9	0	0.0	0.32
	No	77	95.1	19	100.0	
AMI	Yes	1	1.2	1	5.3	0.74
	No	80	98.8	18	94.7	
AF	Yes	6	7.4	1	5.3	0.65
	No	75	92.6	18	94.7	
Ventricular ectopic	Yes	6	7.4	2	10.5	0.5
	No	75	92.6	17	89.5	
SVT	Yes	5	6.2	2	10.5	0.5
	No	76	93.8	17	89.5	
Stroke	Yes	2	2.5	0	0.0	0.49
	No	79	97.5	19	100.0	
PVD	Yes	4	4.9	0	0.0	0.32
	No	77	95.1	19	100.0	

Statistically no significant association had been found between cardiovascular complications of HD and Serum sodium in patient with CKD on HD (P> 0.05). (Table 10).

Table 10.

Relationship between cardiovascular complications and Serum sodium of patient (N=100)

Complication		Serum sodium(mmol/l)				P value
		< 137 (n=37)		≥ 137 (n=63)		
		No.	%	No.	%	
Hypotension	Yes	7	18.9	10	15.9	0.70
	No	30	81.1	53	84.1	
Angina	Yes	4	10.8	3	4.8	0.25
	No	33	89.2	60	95.2	
LV dysfunction	Yes	0	0.0	4	6.3	0.12
	No	37	100.0	59	93.7	
AMI	Yes	0	0.0	2	3.2	0.27
	No	37	100.0	61	96.8	
AF	Yes	2	5.4	5	7.9	0.63
	No	35	94.6	58	92.1	
Ventricular ectopic	Yes	1	2.7	7	11.1	0.14
	No	36	97.3	56	88.9	
SVT	Yes	1	2.7	6	9.5	0.20
	No	36	97.3	57	90.5	
Stroke	Yes	0	0.0	2	3.2	0.27
	No	37	100.0	61	96.8	
PVD	Yes	2	5.4	2	3.2	0.58
	No	35	94.6	61	96.8	

The relation between serum potassium level of patients and cardiovascular complications of HD

No significant association had been found between cardiovascular complications and with Serum potassium (P> 0.05) (Table 11).

Table 11.

Relationship between cardiovascular complications and Serum potassium level of patient (N=100)

Complication		Serum potassium (mmol/l)				P
		< 5 (*n*=54)		≥ 5 (*n*=46)		
		No.	%	No.	%	
Hypotension	Yes	10	18.5	7	15.2	0.66
	No	44	81.5	39	84.8	
Angina	Yes	3	5.6	4	8.7	0.54
	No	51	94.4	42	91.3	
LV dysfunction	Yes	2	3.7	2	4.3	0.87
	No	52	96.3	44	95.7	
AMI	Yes	2	3.7	0	0.0	0.19
	No	52	96.3	46	100.0	
AF	Yes	4	7.4	3	6.5	0.86
	No	50	92.6	43	93.5	
Ventricular ectopic	Yes	4	7.4	4	8.7	0.81
	No	50	92.6	42	91.3	
SVT	Yes	5	9.3	2	4.3	0.34
	No	49	90.7	44	95.7	
Stroke	Yes	2	3.7	0	0.0	0.19
	No	52	96.3	46	100.0	
PVD	Yes	1	1.9	3	6.5	0.24
	No	53	98.1	43	93.5	

The relation between diabetes mellitus and cardiovascular complications of HD

As shown in (Table 12), Angina, AF, and VE were significantly more common in diabetic patients on HD than in non-diabetic, (P< 0.05).

Table 12.

Relationship between cardiovascular complications and Diabetes mellitus in patient on HD (N=100)

Complication		Diabetes mellitus				P value
		Yes(n=29)		No(n=71)		
		No.	%	No.	%	
Hypotension	Yes	7	24.1	10	14.1	0.23
	No	22	75.9	61	85.9	
Angina	Yes	6	20.7	1	1.4	**0.001**
	No	23	79.3	70	98.6	
LV dysfunction	Yes	2	6.9	2	2.8	0.35
	No	27	93.1	69	97.2	
AMI	Yes	1	3.4	1	1.4	0.51
	No	28	96.6	70	98.6	
AF	Yes	5	17.2	2	2.8	**0.010**
	No	24	82.8	69	97.2	
Ventricular ectopic	Yes	5	17.2	3	4.2	**0.029**
	No	24	82.8	68	95.8	
SVT	Yes	2	6.9	5	7.0	0.98
	No	27	93.1	66	93.0	
Stroke	Yes	1	3.4	1	1.4	0.51
	No	28	96.6	70	98.6	
PVD	Yes	2	6.9	2	2.8	0.35
	No	27	93.1	69	97.2	

The relation between hypertension and cardiovascular complications of HD

When we studied the effect of hypertension on cardiovascular complications during HD only three complications showed statistically significant association with the presence of hypertension, these are angina (P=0.030), AMI (P=0.034) and VE (P=0.025) as shown in (Table 13).

Table 13.

Relationship between cardiovascular complications and Hypertension in patients with CKD on HD (*N*=100)

Complication		Hypertension				P value
		Yes (n=38)		No (n=62)		
		No.	%	No.	%	
Hypotension	Yes	9	23.7	8	12.9	0.16
	No	29	76.3	54	87.1	
Angina	Yes	5	13.2	2	3.2	**0.030**
	No	33	86.8	60	96.8	
LV dysfunction	Yes	3	7.9	1	1.6	0.12
	No	35	92.1	61	98.4	
AMI	Yes	2	5.3	0	0.0	**0.034**
	No	36	94.7	62	100.0	
AF	Yes	4	10.5	3	4.8	0.28
	No	34	89.5	59	95.2	
Ventricular ectopic	Yes	6	15.8	2	3.2	**0.025**
	No	32	84.2	60	96.8	
SVT	Yes	3	7.9	4	6.5	0.78
	No	35	92.1	58	93.5	
Stroke	Yes	1	2.6	1	1.6	0.72
	No	37	97.4	61	98.4	
PVD	Yes	1	2.6	3	4.8	0.59
	No	37	97.4	59	95.2	

The relation between smoking and cardiovascular complications of HD

As shown in table 14; Angina was significantly more frequent in smokers than non-smoker, (33.3%) vs. (1.2%), respectively, (P=0.001). Similarly, Ventricular ectopic was significantly more frequent in smokers compared to non-smokers, (22.2%) vs. (4.9%), (P=0.014). Additionally, smokers were significantly more liable to have PVD than no smoker, (16.7%) and (1.2%) of smokers and non-smokers, respectively, had PVD, (P= 0.002).

Table 14.

Relationship between cardiovascular complication and Smoking habit (*N*=100)

Complication		Smoking				P value
		Yes(n=18)		No(n=82)		
		No.	%	No.	%	
Hypotension	Yes	3	16.7	14	17.1	0.97
	No	15	83.3	68	82.9	
Angina	Yes	**6**	**33.3**	1	1.2	**0.001**
	No	12	66.7	81	98.8	
LV dysfunction	Yes	1	5.6	3	3.7	0.71
	No	17	94.4	79	96.3	
AMI	Yes	0	0.0	2	2.4	0.50
	No	18	100.0	80	97.6	
AF	Yes	1	5.6	6	7.3	0.79
	No	17	94.4	76	92.7	
Ventricular ectopic	Yes	**4**	**22.2**	4	4.9	**0.014**
	No	14	77.8	78	95.1	
SVT	Yes	1	5.6	6	7.3	0.79
	No	17	94.4	76	92.7	
Stroke	Yes	1	5.6	1	1.2	0.23
	No	17	94.4	81	98.8	
PVD	Yes	**3**	**16.7**	1	1.2	**0.002**
	No	15	83.3	81	98.8	

Discussion

Many studies document that in patients with chronic kidney disease undergoing hemodialysis, the mortality rate from cardiovascular complications is 10 to 100-fold than in general population. Acute complications commonly occur during routine hemodialysis treatments (HD) due to unsteadiness in the cardiovascular system balance. We will review most important acute cardiovascular complications during hemodialysis. In our study, hypotension was the more frequent complication reported among patients on HD, (17%), followed by Ventricular ectopic (8%), Angina, VF and SVT, (7%) for each, LV dysfunction (4%), Peripheral vascular disease PVD in (4%), and AMI and stroke in (2%) for each.

In the current study, intradialytic hypotension (IDH) was the more frequent complication reported among the studied patient, (17%), hypotension was more frequent in patients who had ultrafiltration (UF) rate of >500. This results are consistence with previous similar several studies include; study done by Bergur V. Stefa´nsson *et al*. (2014) in which intradialytic hypotension occurred in (31.1%) of cases,[41] study by Chang TI et al. (2011)

show that intradialytic hypotension observed in (12.5%)[42], IDH found in (44%) in study performed by Andrulli *et al*. [43], other studies show similar result by; Nette RW *et al*. [44], Knoll GA et al.[45] and Palmer BF *et al* [46]. Many factors may contribute to dialysis hypotension, these include; A rapid reduction in plasma osmolality during dialysis which causes extracellular water to move into the cells this effect plus water loss by ultrafiltration across the dialyzer leads to extracellular volume depletion and may cause hypotension, other factor is rapid fluid removal (high ultrafiltration rate [47, 48]. Other possible causes are autonomic neuropathy, antihypertensive agent, arrhythmias, poor nutritional state, ingestion of food during dialysis (increased splanchnic venous pooling), septicemia, warm dialysate, low sodium dialysate, low dialysate osmolarity and use of acetate rather than bicarbonate as a dialysate buffer[48]. In this study, angina occurred in (7%) and acute myocardial infarction in (2%) of cases. There was a statistically significant association between angina and age in patient with CKD on HD. Angina was more frequent in patients aged ≥ 50 years, (11.5%), (P value = 0.028), and was significantly associated with catheter V-access, where they were more frequent in patients on catheter V-access than other accesses, (P< 0.05) , with diabetes mellitus, (P< 0.05) , with the presence of hypertension, (P=0.030), and with smoking, (P=0.001). Acute myocardial infarction was association with old age, where infarction was more frequent in patients aged ≥ 50 years, but no statistically significant differences had been found. Also, there is association with diabetes mellitus; hypertension and smoking but not reach statistical significance this may be due to small number of patients in this study. In a study of 936 patients on chronic hemodialysis patients by Alfred K. Cheung et al. found that (40%) of the patients had coronary heart disease [49].

During hemodialysis, patients are particularly susceptible to myocardial ischemia for a number of reasons, including: high prevalence of coronary artery atheroma[50], LV hypertrophy[51], intradialytic hypotension and instability [52], and reduced coronary flow reserve (CFR) even in the absence of coronary vessel stenoses [53, 54]. Chronic kidney disease (CKD) is an independent risk factor for coronary artery disease (CAD). Coronary artery disease is the leading cause of morbidity and mortality in patients with CKD. The outcomes of CAD are poorer in patients with CKD [55, 56] Coronary artery disease contributes to (40% to 50%) of deaths among patients who receive dialysis [57]. Approximately (10%-20%) of these deaths are due to acute myocardial infarction (AMI) which tends to occur shortly after the initiation of dialysis with (29%) within 1 year and (52%) within 2 years [58].

In the current study, the arrhythmia observed were; Ventricular ectopic (VE) (8%), atrial fibrillation (AF) and supraventricular tachycardia (SVT) (7%) for each. AF, and VE were significantly associated with DM, (P< 0.05). Ventricular ectopic were significantly more

frequent in smokers compared to non-smokers, (22.2%) vs. (4.9%), (P=0.014) and showed statistically significant association with the presence of hypertension (P=0.025). No statistically significant association with serum potassium and serum sodium. This finding come in line with results reported by Huseyin Bozbas *et al*. in which, Ventricular premature contractions were detected in (37.2%) patients, supraventricular arrhythmia in (16%), and atrial fibrillation in (18%) [59]. Other study by Genovesi S *et al*. showed a (27%) of cases had atrial fibrillation during hemodialysis [60]. Also, AF was reported in (27%) of patients in study performed by Simonetta Genovesi *et al* [61]. In other study by Eduardo Vázquez *et al*., (13.6%) of patients, AF was found [62].

Etiology of Arrhythmia in hemodialysis patients is multi-factorial. Dialytic treatment per se can be considered as an arrhythmogenic stimulus, moreover, uremic patients are also considered as a pro-arrhythmic because of the high prevalence of ischemic heart disease, left ventricular hypertrophy and autonomic neuropathy [63].

During hemodialysis, the incidence of arrhythmias may increase because of rapid fluctuations in electrolyte concentrations (particularly potassium and calcium), in body fluid composition, tissue hydration or adrenergic activation. All were associated with considerable effects on the excitability of the cardiac cells and on arrhythmias [64, 65]. Some studies have found no relationship of plasma potassium to the development of arrhythmias [66, 67]. Other studies have found a correlation between changes in the plasma potassium concentration during dialysis and the incidence of arrhythmias [68, 69].

LV systolic dysfunction found in (4%) during this study. Left ventricular (LV) systolic dysfunction (abnormal left ventricular contraction) is common in hemodialysis patients about (15%) of patients on hemodialysis were found to have LV systolic dysfunction [70]. After the start of hemodialysis, the incidence of systolic heart failure appears to increase [71]. In a study by McIntyre CW *et al*., of (227) patients on hemodialysis in which (40%) developed systolic heart failure by 1 year after starting dialysis therapy [72].

A fall in myocardial blood flow during initiation of hemodialysis may explain the mechanism of acute LV systolic dysfunction. A fall in myocardial blood flow during initiation of hemodialysis and new LV hypokinetic/akinetic regions was observed by using positron emission tomography (PET) scanning in study by Dasselaar JJ *et al*. (2009) and identical results were reported by McIntyre et al. these observations suggest that hemodialysis induces myocardial ischemia. In patients with coronary artery disease, acute myocardial ischemia rapidly impairs LV contractile function [73, 74].

In this study, stroke complications (2%) of cases. Older patients are more likely to have this complication, moreover, there is association of stroke with traditional risk factor such as hypertension and diabetes mellitus was observed and atrial fibrillation also associated but

all show no statistical significance this may be due to small number of stroke that found. Similar results also observed in several other studies, one done by Mark D. *et al*. in which (11.6%) of cases experienced a stroke and the factors associated with stroke were prior stroke, diabetes mellitus, and atrial fibrillation was not significantly associated with stroke [75]. Despite that end stage kidney disease itself remains the largest risk factor associated with stroke incidence; several evidences suggested that hemodialysis itself further increases the risk of stroke. Firstly, the risk of stroke is higher in the first weeks after starting dialysis [76, 77]. Secondly, strokes appear to be more common during a dialysis session [77, 78].

Patients with ESRD on dialysis have an 8–10 times greater incidence of stroke compared to the general population [80, 81]. Older age, hypertension, diabetes and established cerebrovascular disease are all independent risk factors risk factors for stroke with dialysis [82], also in study of atrial fibrillation and risk of stroke in dialysis patients by Wetmore JB et al. show atrial fibrillation was independently associated with a modest risk of ischemic stroke in hemodialysis patient [83].

In this study, peripheral vascular disease (PVD) were accounts for (4%) of total complications, patients with peripheral vascular disease had significantly longer duration of HD than those without Peripheral vascular disease, (7.1 ± 3.7) *vs*. (3.2 ± 2.1), respectively, (P = 0.004). Smokers were significantly more liable to have PVD than nonsmoker, (16.7%) *vs* (1.2%) (P= 0.002).

This finding agrees in line with Sanjay Rajagopalan *et al*., (2006) study of hemodialysis patients (*n*=29 873), were analyzed, which demonstrated that PVD was diagnosed in (25.3%) of cases and smoking were identified, together with the duration of hemodialysis, as significant correlation with development of PVD [84]. In patients with end-stage kidney disease (ESKD), peripheral artery disease (PAD) is common and is associated with substantial morbidity and mortality [85, 86, 87]. PVD were seen more frequently in patient with graft type of vascular access, (P>0.001), than other types. Other thrombosis six times more common in grafts compared with other accesses [88].

Conclusion

Hemodialysis is almost a safe clinical procedure with minimal cardiovascular complications; hypotension was most common reported cardiovascular complication of hemodialysis patients who had a high ultrafiltration rate. Presence of other common comorbidity like diabetic mellitus, hypertension increases the risk of angina, arrhythmia and infarction.

Ethical Approval

The study was approved by the Ethical Committee.

Conflicts of Interest

The authors declare that they have no competing interests.

Authors' Contributions

Both authors shared in conception, design of the study, acquisition of data, and manuscript writing, the critical revising and final approval of the version to be published.

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