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Cardiac Arrhythmia and Blood Pressure Variability in Hemodialysis Patients

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ABSTRACT

Background: end-stage renal disease is a global public health burden bearing high morbidity and mortality, and cardiovascular disease is a major cause of mortality in hemodialysis patients**. Objective:** the aim of this study is detection of arrhythmia and blood pressure variability in hemodialysis (HD) patients. **Patients and Methods:** this prospective observational study included 100 chronic renal failure patients on regular HD came to the hemodialysis center of Al-Azhar University Hospital, New Damietta and Kafr Elsheikh General Hospital. The study was carried out over a period of eight month from July 2017 until September 2018. **Results:** the intradialytic (ID) blood pressure was normal in 38%, ID hypertension was reported in 44% and ID hypotension was reported in 18% of HD patients, also we found that arrhythmia was developed in 84% of HD patients and the prevalence of arrhythmia was VES in 56%, PAC in 50%, SVT in 4%, AF in 8.0%, sinus tachycardia in 26% and sinus bradycardia in 20%. The sympathetic over activity (LF/HF ratio < 1.5) was reported in 38%; and high risk standard deviation of normal-to-normal intervals (SDNN) was reported in 22% and moderate risk in 70.0% while low risk was reported in 8.0% of HD patients.
Conclusion: cardiac arrhythmias are common findings in patients with chronic renal failure on regular hemodialysis.
Keywords: Cardiac Arrhythmia, Blood Pressure Variability, Hemodialysis Patients.

INTRODUCTION

End-stage renal disease is a global public health burden bearing high morbidity and mortality, and cardiovascular (CV) disease is a major cause of mortality in hemodialysis patients [(1)]**.** Several electrocardiographic methods can be used to assess cardiac arrhythmia risk, including measurement of the (QT interval and dispersion, signal averaged ECG and heart rate variability) [(2)]**.** Cardiovascular (CV) autonomic neuropathy and the related risk of arrhythmia may partially explain the observed high rate of (CV) mortality besides the traditional risk factors, including hypertension, diabetes, and dyslipidemia. Cardiovascular autonomic neuropathy can be evaluated by heart rate variability (HRV)[(3)]**.**

It has also been reported that left ventricular (LV) mass is increased from the earliest stages of renal disease (near normal renal function), linked to increased QT interval and dispersion, and with minor rhythm abnormalities, providing link with the high risk of sudden death in this population too. Left ventricular hypertrophy (LVH), systolic and diastolic dysfunction, and autonomic neuropathy were found among patients with end stage renal disease [(4)]**.**

Intradialytic hypertension, an increase in blood pressure from pre to post-hemodialysis, is a current and persistent phenomenon in hemodialysis patients that has been shown to be an independent risk factor for increased morbidity and mortality[(5)]**.**Blood pressure monitoring is common method to evaluate blood pressure variability in hemodialysis patient beside to the Holter ECG monitoring to evaluate heart rate rhythm and variability[(6)]**.**

AIM OF THE STUDY

The aim of this study is detection of arrhythmia and blood pressure variability in hemodialysis patients.

PATIENTS AND METHODS

Patients:

- This prospective observational study included 100 chronic renal failure patients on regular HD came to the hemodialysis center of Al-Azhar University Hospital New Damietta and the Kafr Elsheikh General Hospital. The study was carried out over a period of eight month from July 2017 until September 2018.
- Blood access was through arterio-venous fistula.
- Dialysis was performed for 4 hours, three times weekly using conventional heparin. Blood flow rate was usually 300–350 ml/min with a dialysate flow rate of 500 ml/min. Ultrafiltration varied according to patient's actual weight. The membrane used was polysulfone with surface area suitable for each patient. Bicarbonate was the buffer used throughout the study for all patients.

Inclusion criteria:

- Ability to achieve the dry weight as determined clinically by the nephrologist.
- Controlled hypertension on antihypertensive medications.
- Age more than 18 years old.

Exclusion criteria:

- Unmeasurable T wave.
- Atrial fibrillation.
- Bundle branch block.
- Pacemaker.
- Antiarrhythmic drugs that lengthen the QT interval.
- Patients with impaired systolic function (EF<40%).

Methods:

All patients were subjected to:

I- Before participation in the study, the study protocol was explained for each patient, and an informed oral consent was provided by each patient. **Also, An**

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approval of the study was obtained from Al- Azhar University academic and ethical committee.

II- Full history taking including patient age, sex and residence.

III- Physical examination:

- A careful physical examination was done to probably reveal characteristic of the condition that is underlying (CKD).
- The heart was examined in sequential manner started by inspection, followed by palpation, percussion and auscultation; and any abnormal findings were documented.
- In addition, the presence of diabetes was documented.

IV. Transthoracic Echocardiography:

Patients underwent two dimensional transthoracic echocardiography after HD session to exclude patients with reduced ejection fraction (EF<40%).

Examination was done while patient in left lateral position to bring the heart into better view. All echocardiographic images were recorded for subsequent analysis.

V. Holter ECG monitoring:

Patients underwent Holter ECG monitor before (half hour), during and after HD (4 hours), to detect (QTc, QT interval, heart rate variability (SDNN and LF/HF ratio).

Sympathetic over activity was detected if LF/HF< 1.5, and the SDNN is classified into three degree, low risk if > 100 msec, moderate risk if ranged between 50-100 msec and high risk if <50 msec[7].

IV. Blood samples:

A venous blood sample of 5 ml was drawn before and after dialysis. The sample left to coagulate, centrifuged at 5000 g/minute.

Complete blood count was performed by a hemocytometer (Beckman-Coulter, CA,) after routine daily calibration.

V. Electrocardiograph:

Standard 12 leads ECG was done for every patient after HD to calculate QT dispersion using Bazett formula = QT max – QT min.

VI. Blood Pressure Monitoring:

BP was measured by mercurial sphygmomanometer half an hour before HD and every half hour during and after HD session.

Statistical analysis of data

The collected data was organized, tabulated and statistically analyzed using Statistical Package for Social Science (SPSS) version 18 (SPSS Inc, Illinois, Chicago, USA). For numerical data, mean, standard deviation (SD), minimum and maximum were calculated and for comparison between two groups, the students (*t*) test was used. For comparison between the same group at two different points of time (i.e. before and after dialysis), paired samples (*t*) test was used.

For qualitative (categorical) data, frequency and percent distribution were calculated, and for comparison between groups, the Chi square (*x2*) was calculated. Correlation between two variables was calculated by Pearson's correlation coefficient. For interpretation of results, *p* value less than or equal to 0.05 was considered significant.

RESULTS

Patient demographic data

The present study included 100 chronic renal failure patients on regular HD. Table (1) shows their demographic data and risk factors.

Table (1): Patient demographic data

	Statistics
Age (Mean±SD; ange)	52.46±11.66; 21 - 73
Sex (Male)	84 (84.0%)
Diabetes	26 (26.0%)
Hypertension	82 (82.0%)
HCV	16 (16.0%)
IHD	18 (18.0%)

Heart rate variability parameter and QT interval.
See table (2).

Table (2): HRV parameter and QT interval among study populations.

		Mean	SD	Minimum	Maximum
LF/HF		1.88	0.93	0.40	4.10
SDNN		64.22	25.95	11.00	148.00
QT dispersion		41.20	9.77	20.00	50.00
QT		417.32	41.31	346.00	515.00
QTc		475.82	39.63	348.00	590.00
Sympathetic over activity (LF/HF Ratio < 1.5)				38 (38.0%)	
Abnormal SDNN	High risk (< 50msec)			22 (22.0%)	
	Moderate risk (50-100 msec)			70 (70.0%)	
	Low risk (>100msec)			8 (8.0%)	

Comparison between patients developed arrhythmias and those did not as regard to patient demographics data.

There was no significant difference between those developed arrhythmia and those did not regarding demographics and body weight changes. See table (3).

Table (3): Comparison between patients developed arrhythmias and those did not as regard to patient demographics data.

		Arrhythmia (84)	Negative (16)	P value
Age		53.35±11.49	47.75±11.77	0.08
Sex (Male)		68 (81.0%)	16 (100.0%)	0.06
Diabetes		22 (26.2%)	4 (25.0%)	0.92
Hypertension		68 (81.0%)	14 (87.5%)	0.53
HCV		16 (19.0%)	0 (0.0%)	0.06
IHD		12 (14.3%)	6 (37.5%)	***0.027****
Body weight	Before dialysis	75.02±9.14	75.50±13.88	0.86
	After dialysis	73.69±8.68	74.25±13.67	0.83
	Change%	1.72±1.24	1.67±1.03	0.89

Comparison between patients developed arrhythmias and those did not as regard to laboratory investigation before and after HD.

Serum calcium after dialysis was significantly higher, while serum magnesium after HD was significantly lower in patients developed arrhythmia when compared to those who did not. See table (4)

Table (4): Comparison between patients developed arrhythmias and those did not as regard to laboratory investigation before and after HD.

		Positive (84)		Negative (16)		P value
		Mean	SD	Mean	SD	
Potassium	Before	4.75	0.86	4.75	0.83	0.99
	After	4.13	0.54	4.06	0.35	0.61
Calcium	Before	8.62	0.79	8.38	0.61	0.24
	After	7.64	0.49	7.26	0.95	***0.019****
Magnesium	Before	2.49	0.47	2.71	0.36	0.077
	After	1.96	0.36	2.15	0.27	***0.043****
Sodium	Before	134.40	8.44	131.50	11.04	0.23
	After	131.48	6.59	129.38	9.63	0.28
Phosphorus	Before	5.98	1.16	6.49	1.13	0.11
	After	4.94	0.96	5.32	0.98	0.14
WBCs	Before	6.30	1.78	6.78	5.19	0.49
	After	5.68	1.52	6.22	4.63	0.38
Hemoglobin	Before	10.43	1.13	10.62	1.22	0.55
	After	9.43	1.06	9.70	1.05	0.36
Platelets	Before	142.14	54.62	136.25	47.57	0.68
	After	125.97	50.40	115.37	38.04	0.42
Creatinine	Before	10.45	3.35	12.35	3.69	**0.044***
	After	5.77	1.96	7.46	2.62	**0.004***
Urea	Before	134.92	30.20	152.12	34.63	0.044*
	After	78.19	20.78	88.62	17.24	0.062
Albumin	Before	3.98	0.31	3.93	0.23	0.54
	After	3.85	0.30	3.81	0.26	0.58

Comparison between patients developed arrhythmias and those did not as regard to echocardiographic findings and QT characters.

There was statistically significant higher percentage of LVEF in patients who developed arrhythmias when compared to those who did not. However, no other significant differences were found for any of echocardiographic parameters and QT parameter. See table (5)

Table (5): Comparison between patients developed arrhythmias and those did not as regard to echocardiographic findings and QT characters.

	Positive (84)		Negative (16)		P value
	Mean	S D	Mean	SD	
LVEF	59.45	8.05	55.00	7.76	***0.044****
FS	32.59	5.50	31.37	5.05	0.413
LVEDD	5.61	0.97	5.88	0.87	0.300
LVESD	3.82	0.94	3.92	0.79	0.703
IVS	1.26	0.23	1.17	0.06	0.112
LVPW	1.09	0.22	1.05	0.18	0.419
QT dispersion	41.19	10.57	41.25	3.41	0.982
QT	419.50	39.64	405.87	49.02	0.228
QTc	476.00	40.54	474.87	35.64	0.918

Comparison between patients developed AF and those did not as regard to patient demographics and body weight.

Patients who developed AF were significantly older in age and mainly females when compared with others who did not develop AF.

There was no significant difference between those who developed AF and those who did not develop AF regarding to other data, as described in table (6).

Table (6): Comparison between patients developed AF and those did not as regard to patient demographics and body weight.

		Positive AF		Negative AF		P value
		Mean	S D	Mean	SD	
Age		64.50	6.82	51.41	11.42	***0.002****
Sex (male)		4 (50.0%)		80 (87.0%)		***0.006****
Diabetes		4 (50.0%)		22 (23.9%)		0.11
Hypertension		6 (75.0%)		76 (82.6%)		0.59
HCV		0 (0.0%)		16 (17.4%)		0.19
IHD		0 (0.0%)		18 (19.6%)		0.16
Body weight	Before	77.00	15.54	74.93	9.44	0.57
	After	76.00	15.21	73.58	9.02	0.49
	Change %	1.28	0.88	1.75	1.22	0.29

Comparison between patients developed AF and those did not as regard to laboratory investigation before and after HD

There was significantly lower phosphorus levels after HD, higher sodium after dialysis, and higher platelets before and after HD respectively in patients who developed AF when compared to those who did not.

There was no significant difference between who developed AF and those who did not regard to other laboratory investigations.

Table (7): Comparison between patients developed AF and those did not as regard to laboratory investigations

		Positive AF		Negative AF		P value
		Mean	SD	Mean	S D	
Potassium mEq/L	Before	5.10	0.93	4.72	0.84	0.231
	After	4.20	0.50	4.12	0.52	0.656
Calcium mg/dL	Before	8.85	0.82	8.56	0.76	0.302
	After	7.95	0.58	7.55	0.59	0.067
Magnesium **mg**/dL	Before	2.38	0.32	2.54	0.47	0.336
	After	1.93	0.31	1.99	0.36	0.599
Phosphorus mg/dL	Before	5.58	0.51	6.10	1.20	0.221
	After	4.28	0.45	5.07	0.98	***0.025****
Sodium mEq/L	Before	141.25	8.99	133.30	8.66	***0.015****
	After	135.50	5.32	130.76	7.18	0.072
WBCs	Before	7.75	2.48	6.26	2.60	0.12
	After	6.63	2.25	5.70	2.29	0.27
Hb g/L	Before	10.43	0.60	10.47	1.18	0.91
	After	9.55	0.49	9.47	1.10	0.84
Platelets	Before	199.25	47.74	136.15	51.02	***0.001****
	After	170.00	42.09	120.30	47.29	***0.005****
Creatinine mg/dL	Before	8.80	0.33	10.93	3.56	0.09
	After	4.90	0.13	6.14	2.23	0.12
Urea mmol/L	Before	122.50	16.50	139.00	32.10	0.15
	After	68.25	12.61	80.87	20.83	0.10
Albumin (g/L)	Before	4.00	0.46	3.98	0.29	0.84
	After	3.85	0.37	3.85	0.29	1.00

Comparison between patients developed AF and those did not as regard to echocardiography, QT interval and HRV parameters.

There were significantly higher LVEDD, LVESD, LVPW, QTc, significant prolongation of QTc after HD, and SDNN before and after HD in patients who developed AF when compared with others who did not develop AF.

There was no significant difference between who developed AF and those who did not regard to others echocardiographic and HRV parameters. See table (8)

Table (8): Comparison between patients developed AF and those did not as regard to echocardiographic and HRV parameters.

	Positive AF		Negative AF		P value
	Mean	SD	Mean	S D	
LVEF	56.25	7.30	58.96	8.21	0.37
FS	29.75	4.43	32.63	5.47	0.15
LVEDD	6.32	1.14	5.60	0.93	***0.040****
LVESD	4.60	1.18	3.78	0.87	***0.015****
IVS	1.30	0.20	1.25	0.22	0.534
LVPW	1.28	0.16	1.07	0.21	***0.010****
QT dispersion	35.00	16.04	41.74	8.97	0.061
QT	439.50	11.55	415.39	42.42	0.114
QTc	507.00	51.95	473.11	37.53	***0.020****
LF/HF	1.28	0.44	1.94	0.95	0.06
SDNN	78.50	42.39	62.97	23.98	0.1
QT before	394.50	48.55	401.39	48.24	0.6
QT after	373.25	50.70	390.43	45.37	0.3
QTc before	476.00	52.98	462.80	37.01	0.3
QTc after	478.00	63.34	448.00	36.75	***0.04****
SDNN before	59.00	18.80	42.63	19.46	***0.02****
SDNN after	76.50	18.95	51.26	21.72	***0.002****

Frequency of Intradialytic blood pressure changes.

ID blood pressure was normal in 38%, ID hypertension (IDH) was reported in 44% and ID hypotension was reported in 18%.

Relation between ID blood pressure changes and patient demographics and risk factors

In the present work, patients who had ID hypotension were significantly older than those who had IDH. In addition, IDH was significantly higher in patients with prior hypertension, while ID hypotension was significantly associated with prior HCV infection. See table (9)

Table (9): Relation between ID blood pressure changes and patient demographics and risk factors.

		Normal		ID hypertension		ID hypotension		P-value
		Mean	SD	Mean	SD	Mean	SD	
Age		55.57	11.10	48.04	11.77	56.66	9.04	***0.003****
Sex (male)		32 (84.2%)		36 (81.8%)		16 (88.9%)		0.78
Diabetes		12 (31.6%)		12(27.3%)		2 (11.1%)		0.25
Hypertension		32 (84.2%)		40(90.9%)		10 (55.6%)		***0.004****
HCV		2 (5.3%)		6 (13.6%)		8 (44.4%)		***0.001****
IHD		8 (21.1%)		6 (13.6%)		4 (22.2%)		0.59
Body weight	Before	73.26	9.69	76.72	9.60	75.00	11.21	0.29
	After	72.10	9.44	75.22	9.16	73.77	10.71	0.34
	Change %	1.56	0.93	1.91	1.39	1.56	1.21	0.36

Relation between ID blood pressure changes and systolic blood pressure

There was significant variability between cases with normal, IDH and ID hypotension as regard to systolic blood pressure at different points of time except after dialysis. See Table (10)

Table (10): Variability between cases as regard to their BP during HD.

	Normal		ID Hypertension		ID Hypotension		P value
	Mean	SD	Mean	SD	Mean	SD	
Systolic before	130.52	23.35	154.54	22.76	105.55	28.33	< ***0.001****
SBP1	124.73	25.96	156.81	23.89	104.44	29.55	< ***0.001****
SBP2	127.89	23.15	158.63	21.19	112.22	22.63	< ***0.001****
SBP3	133.15	21.82	152.72	25.91	115.5	27.05	< ***0.001****
SBP4	131.05	18.56	149.09	23.40	115.55	26.61	< ***0.001****
SBP5	128.94	21.02	150.45	21.66	117.77	29.01	< ***0.001****
SBP6	132.63	21.26	145.90	18.71	122.22	29.81	< ***0.001****
SBP7	130.52	19.58	145.00	17.97	120.00	32.89	< ***0.001****
SBP8	133.15	22.06	145.45	22.14	116.66	25.66	< ***0.001****
SBP after	136.31	19.51	136.81	21.21	133.33	41.15	0.88

Comparison between ID blood pressure changes and laboratory investigations before and after HD.

There was significantly higher potassium after dialysis in patients with IDH when compared to patients with ID hypotension. However, there was statistically significant lower calcium in patients who developed IDH when compared to patients with ID hypotension. In addition, both ID hyper and hypotension groups had significantly higher calcium after dialysis when compared to cases with normal blood pressure. Also, there was significantly lower hemoglobin in IDH and hypotension groups when compared to normal patients before and after dialysis. In addition, both urea and creatinine were significantly lower in ID hypotension group when compared to IDH group before and after dialysis. However, serum albumin was significantly increased in ID hypotension when compared to IDH or normal patients before and after dialysis.

There was no significant association between ID blood pressure changes and other laboratory investigations before and after HD. See Table (11).

Table (11): Relation between ID blood pressure changes laboratory investigations.

		Normal		ID hypertension		ID hypotension		P value
		Mean	SD	Mean	S D	Mean	S D	
Potassium mEq/L	Before	4.79	0.92	4.80	0.77	4.57	0.92	0.60
	After	4.19	0.56	4.17	0.48	3.86	0.41	***0.049****
Calcium mg/dL	Before	8.53	0.69	8.51	0.49	8.86	1.30	0.24
	After	7.38	0.73	7.67	0.44	7.79	0.50	***0.022****
Magnesium mg/dL	Before	2.57	0.45	2.46	0.48	2.59	0.43	0.48
	After	1.99	0.35	1.94	0.37	2.10	0.31	0.27
Phosphorus mg/dL	Before	6.21	1.14	5.98	1.18	5.96	1.24	0.61
	After	5.05	0.96	4.93	0.99	5.09	0.98	0.77
Sodium mEq/L	Before	134.00	9.15	134.91	8.93	131.44	8.33	0.38
	After	131.05	7.09	131.82	7.36	129.67	6.89	0.56
WBCs	Before	6.83	3.56	5.86	1.94	6.67	1.12	0.217
	After	6.07	3.10	5.35	1.72	6.12	1.09	0.284
Hb g/L	Before	10.93	1.00	10.18	1.08	10.17	1.28	***0.005****
	After	9.96	0.92	9.22	0.96	9.08	1.23	***0.001****
Platelets	Before	142.52	46.53	141.59	62.67	137.44	43.86	0.945
	After	126.36	42.28	124.86	58.37	118.44	34.76	0.848
Creatinine mg/dL	Before	10.10	2.58	11.67	4.20	9.91	2.55	0.061
	After	5.41	1.32	6.75	2.71	5.62	1.54	***0.011****
Urea mmol/L	Before	130.31	24.25	148.31	37.64	127.22	18.72	***0.009****
	After	75.94	15.04	86.00	25.10	73.11	13.84	***0.025****
Albumin (g/L)	Before	3.87	0.35	4.02	0.26	4.08	0.23	***0.025****
	After	3.75	0.35	3.88	0.27	3.96	0.16	***0.023****

Relation between ID blood pressure changes and echocardiography, QT interval and HRV parameters.

LVEF% was significantly lower in ID hypotension when compared to ID hypertension or normal groups. In addition, LVEDD and LVESD were significantly smaller in ID hypotension when compared to ID hypertension but significantly larger when compared to normal group. Finally, QT dispersion was significantly less in ID hypotension when compared to ID hypertension or normal groups. In addition, there was significant difference between groups as regard to QT before and after HD.

There was no significant association between ID blood pressure changes and others parameters. See Table (12).

Table (12): Relation between ID blood pressure changes and echocardiography, QT interval and HRV parameters

	Normal		ID hypertension		ID hypotension		P value
	Mean	SD	Mean	S D	Mean	S D	
LVEF	61.16	7.75	58.09	8.69	55.22	6.05	***0.029****
FS	33.63	5.02	32.05	5.90	30.67	4.68	0.137
LVEDD	5.30	.88	6.01	0.98	5.54	0.80	***0.002****
LVESD	3.47	.80	4.16	0.98	3.86	0.73	***0.002****
IVS	1.25	.20	1.25	0.24	1.27	0.19	0.953
LVPW	1.05	.22	1.13	0.22	1.09	0.20	0.246
QT dispersion	44.21	7.58	40.45	9.39	36.67	12.83	***0.019****
QT	418.11	37.81	416.68	45.95	417.22	38.55	0.988
QTc	481.21	35.18	478.18	37.66	458.67	49.76	0.120
LF/HF	1.9158	0.90301	1.8514	.88162	1.8900	1.17059	0.95
SDNN	70.00	24.56	61.45	26.97	58.78	25.40	0.2
QT_before	410.89	39.63	405.82	50.28	367.44	46.53	***0.004***
QT_after	377.79	40.87	401.68	46.82	382.00	47.72	***0.04***
QTc_before	469.32	32.46	462.55	46.06	455.56	27.59	0.4
QTc_after	446.37	41.01	458.09	39.86	440.11	35.95	0.2
SDNN_before	46.42	23.63	42.23	15.02	42.89	21.91	0.6
SDNN_after	52.79	25.67	55.86	18.72	48.00	24.13	0.4

DISCUSSION

In the present work the age of studied cases ranged between 21 and 73 years, with mean age 52.46±11.66 years, which is similar to **Mahmoud and his working group** [8] who reported that mean age of HD patients was 50.81± 12.45 (range 22-75) years. In contradiction with **Vaia and Despina** [9] who reported that mean age of HD patients was 62 ± 15 years, **Chen and his working group** [10] (mean age 61.2±11.3 years) and **Malhis and his working group** [11] who reported that mean age 44±17 years. This discrepancy in mean ages between the studies may be attributed to different inclusion criteria and variation in population and the number of included cases in each study.

In the present work, body weight was significantly decreased after dialysis when compared to pre-dialysis values (*P* value<0.001), which is similar to **Vaia and Despina**[9] (*P* value 0.02), and **Wen *et al.***[12] (*P* value <0.0001).

In the present work, there was significant decrease of all electrolytes after dialysis when compared to values before dialysis (P value <0.001), which is similar to **Mahmoud *et al.***[8].

In the present work, WBCs, hemoglobin, platelets, creatinine, urea and serum albumin levels were significantly decreased after dialysis (P value <0.001) which is similar to **Mahmoud *et al.***[8].

In the present work 80% of patients had LVH, IVS ranged from 0.90 cm to 1.80 cm, with mean value 1.25±0.21 cm; while LVPW ranged from 0.70 cm to 1.70 cm with mean value 1.09±0.21 cm. This is in contradiction with the results of **Shamir *et al.***[13] who found LVH in 27% of HD patients. This difference between our results is mainly because they used cardiac MRI to evaluate LV mass and the LVH was defined as LV mass index (LVMI) ≥ 45 g/m-height for women and ≥ 49 g/m-height for men based on established guidelines. Also his criteria included age >18 years on maintenance HD ≥ 3 months, and predialysis SBP≥ 155 mm Hg while we included age>21 years on maintenance HD ≥ 6 months.

We observed that the patients on regular HD had BPV as regard to systolic blood pressure at different times of measurements during HD which was similar to **Flythe and Brunelli**[14] and **Martino *et al.***[15].

We found that 44% of HD patients developed IDH which was higher in younger patients with prior hypertension. In contradiction with the results of **Vaia and Despina**[9], who found that 19.7% of HD patients developed IDH and was older in age. This difference between results was mainly because they included 76 HD patients, and BP data were considered over 12 dialysis sessions per patient by using 24- hour ambulatory BP monitor.

In the present work we found that 18% of HD patients developed ID hypotension and were older in age. It was similar to the results of **Kuipers *et al.***[16] who denoted that 21% of HD patients developed ID hypotension and were older in age. We found that LVEF, LVEDD and LVESD were significantly smaller in patients with ID hypotension when compared to IDH. This was similar to the results of **Soliman *et al.***[17].

In the present work we found that the prevalence of arrhythmia was 84% of study populations, VES in 56%, PAC in 50%, SVT in 4%, AF in 8.0%, sinus tachycardia in 26% and sinus bradycardia in 20%. This frequency is similar to the results of **Mahmoud *et al.***[8] who reported that the incidences of arrhythmias before and during HD were VES 60%, PAC 40%, and AF was 5.6%. And **Hamid**

et al. [18] who reported that the incidence of arrhythmias were VES 64%, PAC 40%, and AF rhythm 2.7%.

In the present work we found that there was no significant difference between patients who developed arrhythmia and those who did not regarding electrolytes before and after HD except for significantly lower level of magnesium and higher level of calcium in patients with arrhythmia, and according to echocardiography parameters they had preserved LVEF% when compared to other patients. It was similar to the results of **Fabiana *et al.*** [19] **and Mozos** [20]**.**

We found patients who developed VES were significantly males, older in age, had LVH and more changes in body weight percentage and had significantly lower serum sodium before and after dialysis when compared to those who did not develop VES. It was similar to the results of **Fabiana *et al.*** [19]**.**

In the present work we found that patients who developed PAC had significantly lower magnesium level and significantly lower QTc after HD when compared to patients who did not developed PAC. According to our knowledge we did not found researches comparing between patients on regular HD and developed PAC and others who didn't not develop as regard to electrolytes, echocardiographic parameters and QT interval.

In the present work we found that patients who developed SVT were significantly younger in age, had significantly ID hypotension during and after HD, longer QTc after and longer QT interval before HD when compared to those who did not develop SVT. According to our knowledge we did not find researches, which compared between patients on regular HD who developed SVT and others who didn't not develop as regard to electrolytes, echocardiographic parameters and QT interval.

In the present work we found significant changes in QT and QTc intervals before and after HD, which were longer of pre-HD QT and QTc intervals with a significant further increase in these intervals post-HD, and no changes of QT dispersion which was in normal range (20-50 ms). It was similar to the results of **Malhis *et al.*** [11] and **Reza *et al.*** [21] as they found QT, QTc longer duration before and after HD. They concluded that this prolongation is a great mark that suggests high risk for ventricular arrhythmia.

We found no significant difference in QT and QTc intervals before and after HD in diabetic patients when compared with non-diabetic patients. In contradiction with **Malhis *et al.*** [11] and **Reza *et al.*** [21] results as they found such correlation in their studies between hyperglycemia and increased QT interval. This discrepancy in results may be because our patients were controlled diabetes mellitus.

We found positive correlation between QT interval before and after HD with calcium, and positive correlation between QTd and potassium and magnesium before and after HD. It was similar to the results of **Reza *et al.*** [21].

In the present work we found QT interval and QTd before and after HD were significantly decreased in patients who developed ID hypotension when compared to the normal and patients with IDH. It was similar to result of **Malhis *et al.*** [11]**.**

In the present work we found significant changes in parameters of HRV as decrease of LF/HF ratio during HD and increase of SDNN after HD. It was similar to the results of **Chen *et al.*** [10]**.**

In the present work we found significant decrease of LF/HF ratio in diabetic patients, weak positive correlation between age and SDNN before HD, and correlation between IHD patients and SDNN after HD which was similar to the results of **Niu *et al.*** [22]**.**

In the present work we found weak positive correlation between SDNN before HD and sodium and calcium levels. In contradiction with the results of **Wen *et al.*** [12] which concluded that no significant correlation between electrolytes changes and HRV parameters.

In the present work we found significant correlation between changes in LF/HF and SDNN in patients who developed VES, SDNN after HD in patients who developed PAC, and SDNN before and after HD in patients developed AF.

CONCLUSION

1. Cardiac arrhythmias are common findings in patients with chronic renal failure on regular hemodialysis.
2. In addition, the blood pressure varies between hypertension and hypotension; however, blood pressure variability throughout the hemodialysis did not reach statistical significance.
3. Different variables are associated with development of cardiac arrhythmias and blood pressure changes. However, the causal-effect relationship is out the scope of the present work.
4. Changes in HRV may play an important role of development of arrhythmia in HD patients.

RECOMMENDATIONS

It is recommended to check all patients on hemodialysis for cardiac arrhythmias and blood pressure variability before, during and after their hemodialysis sessions, and provide appropriate management in due time for each patient according to his/her clinical situation.

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