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A STUDY OF RIGHT VENTRICULAR DYSFUNCTION IN DIALYSIS PATIENTS.

Nephrology

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ABSTRACT

Aim - To study right ventricular dysfunction in dialysis patients and compare the same between hemodialysis and peritoneal dialysis patients. **Methods**-This prospective cross-sectional study was conducted in Dialysis patients in a tertiary care hospital in North India for a period of 1 year. Both hemodialysis and peritoneal dialysis patients were included in the study. A detailed Echocardiography was done with special emphasis on Right Ventricular Functions. **Results:** 56 patients were included in the study and 41 (73.2%) were undergoing hemodialysis and 15 (26.8%) were on peritoneal dialysis. 44% (78.6%) patients had Right ventricular diastolic dysfunction while 12 (21.4%) had no dysfunction while taking into consideration 4 echocardiographic parameters of right ventricular dysfunction. Tricuspid Annular Plane Systolic Excursion (TAPSE), as a measure of Right Ventricular Dysfunction (TAPSE <17mm) was found in 17 (41.5%) hemodialysis patients and only in 2 (13.3%) peritoneal dialysis patients($p<0.05$) suggesting better preservation of cardiac function in Peritoneal dialysis patients. There was no significant difference between in RVD in patients undergoing HD through RC verse BC fistula. **Conclusion:**High Prevalence of RVD (78.6%) was found in patients undergoing dialysis in our study. The prevalence was higher in HD group compared to PD group 87.8 vs 53.3%, ($p<0.05$) suggesting better preservation of right ventricular dysfunction in PD patients.

KEYWORDS

Echocardiography, Fistula, Hemodialysis, Peritoneal dialysis Right ventricular dysfunction.

INTRODUCTION -

Cardiovascular disease is leading cause of mortality in patients undergoing dialysis, accounting 50% of deaths[1]. A similar cardiovascular mortality rates in a 30-year-old patient undergoing dialysis and 80-year-old individual from general population is seen[2].

The traditional risk factors for cardiovascular disease do not completely explain this high risk, which seems to be influenced by the so-called nontraditional risk factors associated with CKD[3]. Various nontraditional risk factors that are responsible for increased Cardio vascular disease in CKD include albuminuria, lipoprotein(a) and apo(a)isoforms, lipoprotein remnants, abnormal mineral metabolism, oxidative stress ,inflammation and malnutrition, altered nitric oxide and endothelial balance. These factors accelerate the course of coronary artery disease[4] and is associated with a higher prevalence of ventricular hypertrophy, myocardial fibrosis, valvopathies , arrhythmias, and sudden death[5]. ESRD patients with volume overload have increased levels of vasopressin , increased renin-angiotensin-aldosterone activity and sympathetic activity that contribute to right ventricular impairment regardless of the high venous return from a high-flow AVF. Hence echocardiography has great role to play and there is increasing evidence of the pivotal role of echocardiography in improvement of quality of global clinical evaluation of advanced CKD patients[6].

In recent years, the assessment of right ventricular function by tissue Doppler imaging (TDI) has been established as a common approach to detect preclinical abnormalities of cardiac function and has also been proposed as a reliable predictor of prognosis [7]. Previous works regarding the relation between pulmonary hypertension and dialysis have mostly investigated the impact of volume overload on TDI indices of left ventricular function, showing an increased prevalence of diastolic dysfunction in these patients [8,9]. Most of the available studies have focused on LV function in dialysis patients. Data on the prevalence of RVD in patients undergoing chronic dialysis are still lacking. A few studies that have investigated the impact of haemodialysis (HD) on RV functions have reported deterioration of RV systolic and diastolic functions in HD patients and very few have studied the impact on peritoneal dialysis patients. Importantly, RVD may also affect left ventricular filling via interventricular interaction[10]. RVSD is a significant predictor of mortality in heart failure patients, regardless of left ventricular systolic dysfunction and valvular disease.[11-12]

RV dysfunction is a predictor of adverse outcomes in many heart diseases; however, there is a lack of data regarding the changes in RV geometry and function in patients with ESRD.

Aims And Objective

To study the prevalence of right ventricular dysfunction in dialysis patients and to compare the impact of haemodialysis and peritoneal dialysis on right ventricular dysfunction.

MATERIAL AND METHODS

This prospective observational study was conducted in CKD - 5D patients in a tertiary care hospital in North India. Patients on haemodialysis and peritoneal dialysis were included in the study. HD patients were further divided into two categories, dialysis through radio-cephalic and through brachiocephalic fistula.

Inclusion Criteria

All patients aged $\geq$ 18 years on haemodialysis or peritoneal dialysis for at least 3 months were included. Haemodialysis patients receiving at least two sessions of dialysis/week and peritoneal dialysis patients with minimum 3 exchanges /day.

Exclusion Criteria

Patients with rheumatic heart disease, congenital heart disease or atrial fibrillation, connective tissue disorder, pulmonary thromboembolic disease,Chronic obstructive pulmonary disease were excluded .Patients on dialysis through temporary vascular access and patients who are not willing to participate were also excluded.

Methodology

A written informed consent was taken. All patients fulfilling the inclusion and exclusion criteria were enrolled in the study .Dialysis data regarding vascular access, volume status and adequacy of dialysis was recorded. All the laboratory parameters including

Echocardiography was done in the same week. ECHO was done post dialysis (within one day of dialysis) by a trained technician or a doctor. In all patients evaluation of both RV and LV function was done by M-mode, 2D and Doppler echocardiography by using ECHO machine SIEMENS ACUSON SC2000 with 4V1c transducer with a frequency of 3.5 MH in the left lateral and supine position. All measurements were performed according to the recommendations of the American Society of Echocardiography Recommendations 2015[8].

Right ventricular dysfunction was assessed using four ECHO parameters

1. Tricuspid annular plane systolic excursion (TAPSE) . Values lower than 17 mm are highly suggestive of RV systolic dysfunction.
2. Right ventricular index of myocardial performance (RIMP). A RIMP greater than 0.54 by TDI is indicative of RV dysfunction.
3. Tricuspid annular motion was evaluated by tissue Doppler to measure the longitudinal velocity of the tricuspid annulus. Velocity has been named the RV S' or systolic excursion velocity. Normal values for pulsed tissue Doppler S wave is 14.1 ± 2.3 or >9.5 cm/s.
4. The RV fractional area change (FAC) provides an estimate of global RV systolic function.Normal RV FAC is greater than 35%.

Statistical Analysis – Sample size was 56 ,quantitative variables were expressed as mean or median with standard deviation or interquartile range. Qualitative variables were expressed as frequency of occurrence with percentages. Appropriate statistical test such as Mann Whitney U test, "T" test and "chi square test" was used whenever required. A "P" value < 0.05 was considered statistically significant. Data was entered in Microsoft excel and statistical package for social sciences "SPSS" version 21.0. Armonk, NY: IBM crop, was used for analysis.

RESULTS AND DISCUSSION

Study included 56 patients with mean Age (Years) of 56.88 ± 11.71.Among them 38 (67.9%) were male and 18 (32.1%) were female. 41 (73.2%) were on haemodialysis and 15 (26.8%) were on peritoneal dialysis. Among haemodialysis group there were two subgroups based on type of fistula, brachiocephalic fistula in 24 (58.5%) patients and 17 (41.5%) having radio - cephalic fistula. Blood pressure in haemodialysis group was 141 ±16.31mmHg and 129.33 ±7.99 mmHg in peritoneal dialysis group and the difference was statistically significant concluding better blood pressure control in peritoneal dialysis patients. There was no statistical difference between the two groups with regard to cause of renal failure and laboratory parameters except for serum albumin (g/dl) which was higher in haemodialysis group (3.85 ±1.14g/dl) as compared to peritoneal dialysis group (3.13 ± 0.55mg/dl) and was statistical significant. This could be due to more protein losses during PD compared to HD. Dialysis vintage of participants was 27.12 ± 30.66 months and average interdialytic weight gain was 2.48 ± 1.16. The mean Kt/V of participants was 3.77 ± 16.79.

Prevalence of Right ventricular dysfunction in dialysis patient was 78.6% (n=44), in HD group 87.8% (n=36) and PD group 53.3% (n=8). The prevalence was higher in HD group compared to PD group (87.8 vs 53.3%, p <0.05). Not much difference was seen between haemodialysis sub groups, dialysis through Brachio-cephalic fistula and radio-cephalic fistula 87.5% (n=21) vs 88.2% (n=15) (p>0.05). However, duration of dialysis through Radio cephalic fistula was 35.12 ± 43.74 months compared to duration through brachiocephalic fistula was 17.96 ± 17.40 months and was not statistically significant (p>0.05)**.** S.Yilmaz et al [14] studied (13) 64 patients aged between 18 and 85 years who were on routine haemodialysis with > 2 haemodialysis sessions per week for at least 3 month via AVF . They concluded that excessive AVF blood flow was independently associated with impaired right ventricular dysfunction possibly by increasing right ventricular preload. However they did not compare RVD between BC and RC fistula.

In a study by Panneni et al[15] 220 patients were enrolled. Healthy controls (n = 100), patients on peritoneal dialysis (n = 26), haemodialysis (HD) with radial arteriovenous fistula (n = 62), and HD with brachial AVF (n = 32). Echocardiography including tissue Doppler imaging (TDI) of the right ventricle was performed in all patients. RVD was identified in 79 dialysis patients (65.8%). The average RV MPI as measure of RV dysfunction was significantly higher in dialysis patients compared with controls and a further rise was found in patients with brachial compared with radial AVF. RVD was more in patients with brachial AVF compared with the radial access (90.6 vs. 61.3%, p < 0.001). Right ventricular dysfunction in patients undergoing haemodialysis could be explained by uraemia, fluid retention, anaemia, hyperparathyroidism and a high flow AVF 16,17.

In our study the average LV Ejection fraction in Haemodialysis group was 44.34 ± 10.82% and Peritoneal dialysis group was 53.07 ± 8.11 % and the difference was statistically significant (p<0.05). Among the four parameters for Right ventricular dysfunction TAPSE, RVFAC, RIMP and S-Prime, TAPSE <17mm was found in 17 (41.5%) HD patients and only 2 (13.3%) peritoneal dialysis patient and was statistically significant (p<0.05) rest all other ECHO parameters of RV dysfunction showed no significant statistical difference.These findings concluded better preservation of cardiac function in PD patients than HD patients.

Demirci D et al [18] studied RVD in peritoneal dialysis patients . 36 patient on PD and 37 healthy controls. Echocardiography of the RV was performed in all of the patients using tissue Doppler imaging (TDI). They concluded that RVF estimated using conventional Doppler and TDI echocardiography were preserved in PD patients .

In another study by Momtaz et al[3] which included healthy controls (n = 24) and HD patients (n = 50). Echocardiography including tissue Doppler imaging (TDI) of the RV was performed in all patients. HD patients had significantly lower RV systolic indices than control participants. They concluded that subclinical RV dysfunction is increased among HD patients.

In a cross-sectional study by Juan Manuel et al[19] a transthoracic echocardiographic examination was performed in patients on Haemodialysis. Right ventricular systolic function was evaluated using TAPSE. Fifteen patients had RVSD (TAPSE <14mm) and 85 patients had no RSVD. They found that one of the independent contributors to RVSD was arterio-venous fistula time. The prevalence of RVD as measured by TAPSE was low 15% compared to 33.9% in our study. This difference of prevalence could be due to low cut off for TAPSE in their study (14 mm compared to 17 mm in our study). More over the prevalence of RVD in their study was only 15% compared to 78.6% in our study. This difference can be attributed to more number for factors (4) for RVD taken in our study compared to one factor in their study.

CONCLUSION

We concluded from our study that RVD assessment is of paramount significance in patients undergoing dialysis as RVD is present in large number of patients undergoing dialysis. The prevalence of RVD was 78.6%. The prevalence is higher in HD group compared to PD group (87.8 vs 53.3%, p<0.05). Moreover, while assessing RVD all the four parameters for measuring RVD – TAPSE, RIMP, RVFAC, S should be measured as this increases the sensitivity of detecting RVD. Further we can conclude that PD can be considered as a better dialysis modality as far as RVD is concerned but whether it relates to morbidity or mortality is not evaluated in this study

Table 1: Summary of RVDDamong dialysis patients

RVDD	Yes	No
Any Factor Positive	44 (78.6%)	12 (21.4%)
TAPSE <17mm	19 (33.9%)	37 (66.1%)
RV FAC <35%	5 (8.9%)	51 (91.1%)
RIMP >0.54	29 (51.8%)	27 (48.2%)
S PRIME <9.5cm/s	10 (17.9%)	46 (82.1%)

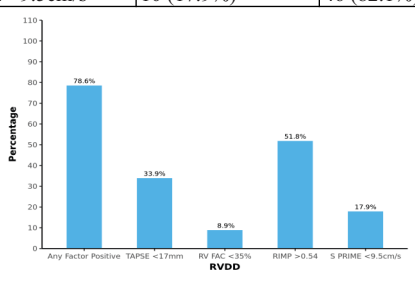

Chart-1 RVDD in Dialysis Patients

Table 2- Clinical Profile Of Patients In The Study

Parameters	Dialysis Type		p value
	Hemodialysis (n = 41)	Peritoneal Dialysis (n = 15)	
Age (Years)	56.61 ± 11.95	57.60 ± 11.41	0.91
Age			0.46
21-30 Years	3 (7.3%)	0 (0.0%)	
41-50 Years	7 (17.1%)	5 (33.3%)	
51-60 Years	16 (39.0%)	3 (20.0%)	
61-70 Years	10 (24.4%)	5 (33.3%)	
71-80 Years	5 (12.2%)	2 (13.3%)	
Gender			0.05
Male	31 (75.6%)	7 (46.7%)	
Female	10 (24.4%)	8 (53.3%)	
Systolic BP (mmHg)***	141.95 ± 16.31	129.33 ± 7.99	0.00
Diastolic BP (mmHg)	82.34 ± 6.59	81.07 ± 6.23	0.68
Cause Of Renal Faliure			0.62
Diabetes	21 (51.2%)	5 (33.3%)	
Hypertension	14 (34.1%)	7 (46.7%)	
CIN	4 (9.8%)	2 (13.3%)	
CGN	1 (2.4%)	1 (6.7%)	
Unknown	1 (2.4%)	0 (0.0%)	
Urine Output			0.165[2]
Maintained	26 (63.4%)	13 (86.7%)	
Oliguric	8 (19.5%)	0 (0.0%)	
Anuric	7 (17.1%)	2 (13.3%)	
Dialysis Vintage (Months)	25.07 ± 31.82	32.73 ± 27.45	0.33
Average Intradylitic Weight Gain (Kg)***	2.57 ± 1.15	1.26 ± 0.23	0.03
KT/V***	4.58 ± 19.44	1.43 ± 0.23	0.02
Hemoglobin (g/dL)	9.39 ± 1.34	10.02 ± 1.24	0.10
Haemtocrit (%)	30.79 ± 5.28	32.27 ± 5.46	0.37
Albumin (g/dL)***	3.85 ± 1.14	3.13 ± 0.55	0.00
Calcium (mg/dL)	8.94 ± 0.99	8.63 ± 1.01	0.31
Phosphate (mg/dL)	9.35 ± 18.58	5.52 ± 2.98	0.46
iPTH	348.29 ± 292.53	304.21 ± 150.32	0.79

Table-3: Comparison Of Echocardiography Parameters Between Haemodialysis And Peritoneal Dialysis Groups

PARAMETER	HD group	PD group	P - value
LV End Systolic Volume	32.15 ± 20.35	36.07 ± 14.71	0.23
LV End Diastolic Volume	61.47 ± 43.59	80.44 ± 35.39	0.13
LV Ejection Fraction***	44.34 ± 10.82	53.07 ± 8.11	0.00
TAPSE (mm)***	17.49 ± 4.55	20.06 ± 3.32	0.02
RV End Diastolic Area***	45.18 ± 15.84	23.40 ± 13.88	<0.0
RV End Systolic Area***	20.90 ± 6.72	11.06 ± 4.33	<0.0
RV FAC	52.53 ± 12.75	51.49 ± 14.26	0.80
IVCT (mL/s)	65.64 ± 10.94	64.07 ± 15.05	0.88
IVRT (mL/s)	72.14 ± 17.77	68.87 ± 16.19	0.49
ET (mL/s)	237.98 ± 29.56	250.00 ± 27.27	0.16
RIMP	0.59 ± 0.12	0.53 ± 0.09	0.08
S PRIME (cm/s)	13.02 ± 3.40	12.36 ± 2.60	0.53
Tricuspid Regurgitation Velocity (m/s)	3.18 ± 2.36	2.44 ± 0.66	0.19
RVDD: Any Factor Positive (Yes)***	36 (87.8%)	8 (53.3%)	0.01
RVDD: TAPSE <17mm (Yes)***	17 (41.5%)	2 (13.3%)	0.04
RVDD: RV FAC <35% (Yes)	4 (9.8%)	1 (6.7%)	1.00
RVDD: RIMP >0.54 (Yes)	23 (56.1%)	6 (40.0%)	0.28
RVDD: S PRIME <9.5cm/s (Yes)	8 (19.5%)	2 (13.3%)	0.71
Number of Factors for RVDD***			0.02
None	5 (12.2%)	7 (46.7%)	
1 Factor	25 (61.0%)	7 (46.7%)	
2 Factors	7 (17.1%)	0 (0.0%)	
3 Factors	3 (7.3%)	0 (0.0%)	
4 Factors	1 (2.4%)	1 (6.7%)	

Table 4: Association between Type of A-V fistula

Parameters	Ascess		p value
	Brachiocephalic Fistula (n = 24)	Radiocephalic Fistula (n = 17)	
Age (Years)	57.00 ± 11.75	56.06 ± 12.57	0.71
Age			0.53
21-30 Years	2 (8.3%)	1 (5.9%)	
41-50 Years	2 (8.3%)	5 (29.4%)	
51-60 Years	11 (45.8%)	5 (29.4%)	
61-70 Years	6 (25.0%)	4 (23.5%)	
71-80 Years	3 (12.5%)	2 (11.8%)	
Gender			0.48
Male	17 (70.8%)	14 (82.4%)	
Female	7 (29.2%)	3 (17.6%)	
Systolic BP (mmHg)	141.67 ± 14.94	142.35 ± 18.55	0.96
Diastolic BP (mmHg)	81.33 ± 5.98	83.76 ± 7.31	0.21
Cause Of Renal Faliure			0.07
Diabetes	13 (54.2%)	8 (47.1%)	
Hypertension	5 (20.8%)	9 (52.9%)	
CIN	4 (16.7%)	0 (0.0%)	
CGN	1 (4.2%)	0 (0.0%)	
Unknown	1 (4.2%)	0 (0.0%)	
Urine Output			0.25
Maintained	17 (70.8%)	9 (52.9%)	
Oliguric	5 (20.8%)	3 (17.6%)	
Anuric	2 (8.3%)	5 (29.4%)	
Dialysis Through fistula (Months)	17.96 ± 17.40	35.12 ± 43.74	0.15
Average Intradylitic Weight Gain (Kg)	2.24 ± 1.22	3.05 ± 0.86	0.05
KT/V	6.72 ± 25.41	1.55 ± 0.15	0.67
Hemoglobin (g/dL)	9.58 ± 1.44	9.11 ± 1.17	0.25
Haemtocrit (%)	31.47 ± 5.92	29.82 ± 4.20	0.30
Albumin (g/dL)	3.88 ± 0.65	3.81 ± 1.62	0.20
Calcium (mg/dL)	8.82 ± 0.98	9.12 ± 1.02	0.35
Phosphate (mg/dL)	12.12 ± 24.07	5.44 ± 1.67	0.78
iPTH	318.28 ± 130.97	390.65 ± 431.29	0.40
Fistula Blood Flow (cm/s)***	474.21 ± 118.25	374.71 ± 112.98	0.00
LV End Ststolic Volume	31.77 ± 20.98	32.68 ± 20.05	0.94
LV End Diastolic Volume	60.15 ± 41.87	63.35 ± 47.15	0.88
LV Ejection Fraction	44.12 ± 11.78	44.64 ± 9.66	0.82
TAPSE (mm)	18.34 ± 5.05	16.29 ± 3.51	0.13
RV End Diastolic Area	44.48 ± 15.97	46.16 ± 16.09	0.74
RV End Systolic Area	19.56 ± 5.50	22.79 ± 7.94	0.15
RV FAC	54.32 ± 13.02	50.00 ± 12.30	0.30
IVCT (mL/s)	65.10 ± 13.30	66.41 ± 6.63	1.00
IVRT (mL/s)	74.90 ± 17.53	68.24 ± 17.88	0.24
ET (mL/s)	236.29 ± 33.42	240.35 ± 23.83	0.65
RIMP	0.60 ± 0.13	0.56 ± 0.11	0.49
S PRIME (cm/s)	13.61 ± 3.26	12.19 ± 3.51	0.19
Tricuspid Regurgitation Velocity (m/s)	2.98 ± 1.42	3.47 ± 3.30	0.86
RVDD: Any Factor Positive (Yes)	21 (87.5%)	15 (88.2%)	1.00
RVDD: TAPSE <17mm (Yes)	8 (33.3%)	9 (52.9%)	0.20
RVDD: RV FAC <35% (Yes)	1 (4.2%)	3 (17.6%)	0.29

RVDD: RIMP >0.54 (Yes)	14 (58.3%)	9 (52.9%)	0.73
RVDD: S PRIME <9.5cm/s (Yes)	3 (12.5%)	5 (29.4%)	0.24
Number of Factors for RVDD			0.45
None	3 (12.5%)	2 (11.8%)	
1 Factor	17 (70.8%)	8 (47.1%)	
2 Factors	3 (12.5%)	4 (23.5%)	
3 Factors	1 (4.2%)	2 (11.8%)	
4 Factors	0 (0.0%)	1 (5.9%)	

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