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ORIGINAL ARTILCE

Assessment of Right Ventricular Function in Patient with Chronic Renal Failure on Regular Dialysis by Echocardiography

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ABSTRACT

Background: 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. **Methods:** Our study had been carried out in cardiology department; zagazig university. Our study had included 228 patients divided them into two groups(case and control group) were compared regarding to clinical and echocardiographic data.114 patients with end stage renal failure on regular hemodialysis through permanent brachial arterio-venous fistula (AVF). **Results:** No statistically significant differences were found among the groups regarding age and gender, there was statistical significance difference between the two groups in all risk factors ($P < 0.01$) except for Smoking there was no significant statistical difference, Among HD RV dimensions were significantly larger (Basal level – Mid level – Longitudinal length) compared to control group ($P < 0.01$)).Doppler Tie index was significantly higher in HD patients with mean value of (0.56±0.12) when compared to control group (0.36±0.032) with (P value < 0.001), denoting significantly more depressed RV function in HD patients. **Conclusions:** Myocardial Performance index (tie index) and S wave measured by tissue Doppler are simple and quick parameters that can used in HD patients to asses global right ventricular function with good accuracy .Both parameters not affected by right ventricular geometry and have the advantage of simultaneously recording both systolic and diastolic velocity patterns .

Key words:
Right ventricular function , Hemodialysis ,echocardiography

INTRODUCTION

Hemodialysis (HD) which is usually carried out via a surgically created native arterio-venous fistula (AVF) has been associated with an increased risk of pulmonary hypertension , a condition reported as a predictor of mortality in these patients(1) .

Although patients undergoing chronic dialysis exhibit an increased prevalence of pulmonary hypertension during treatment, data on the development of right ventricular dysfunction (RVD) are lacking. Moreover, in patients with pulmonary hypertension, survival has been related to cardiac function rather than pulmonary pressure values(2) .

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(3).

This work aimed to investigate the impact of chronic dialysis therapy on right ventricular function in patient with ESRD.

METHODS

Patients

Our study had been carried out in cardiology department; zagazig university. Our study had included 228 patients divided them into two groups(case and control group) were compared

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regarding to clinical and echocardiographic data.114 patients with end stage renal failure on regular hemodialysis through permanent brachial arterio-venous fistula (AVF).

Inclusion criteria

Patients with ESRD with regular hemodialysis (Patients undergoing hemodialysis had been on maintenance therapy for at least 3 months and were receiving HD sessions 2-3 times per week).

Exclusion criteria

Based on patient history, physical examination, ECG, and echocardiography, we will exclude patients suffering from the following:

- Other rhythm than in sinus rhythm.
- Pulmonary hypertension due to other cardiac or chest cause.
- The presence of a pacemaker or defibrillator leads in right ventricle.
- Complete right or left bundle branch block.
- Left ventricular systolic dysfunction and/or valvular disease.

Ethical consideration:

Written consent was obtained from every patient after explanation of the procedure. Medical research and ethics committee of Zagazig University approved the study. The work was carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Patients were divided into two groups (case and control group) according clinical and echocardiographic data.

1. Clinical Evaluation: Detailed history and clinical examination with special emphasis on: Age ,Gender ,Risk Factors for cardio vascular disease and Presence of dyspnea and its grades.

2. ECG:

3. Echocardiography examination: Detailed TTE was performed to all patients during study using GE Vivid I machine ultrasound with P4-2 1.8 MHZ transducer. The machine had tissue Doppler imaging capability. The conventional TTE was performed in accordance with the recommendations of the American Society of Echocardiography (ASE) and European Association of Echocardiography (EAE).The echocardiogram was performed with the patient breathing quietly and lying in the supine or the left lateral position to assess the left ventricular ejection fraction (LVEF) by biplane modified Simpson method and LV diastolic function

The following parameters will be done:

- ***A conventional left side assessments:***

Assessment of the right side of the heart:

i. ***Measurement of the right ventricular dimensions*** **(basal, mid and long):**

ii. ***Measurement of the right atrium diameter:***

iii. ***Measurement of right ventricle free wall:***

iv. ***Measurement of the right ventricular area*** **and calculation of the fractional area change (RVFAC):**

RV FAC = RV end diastolic area – RV end systolic area / RV end diastolic area

v. ***Measurement of the tricuspid plane systolic excursion (TAPSE):***

vi. ***Systolic pulmonary artery pressure SPAP:***

vii. ***Systolic excursion velocity at lateral tricuspid annulus (S wave):***

viii. ***Measurement of Myocardial Performance Index (MPI) or (Tei index):***

1- Using Doppler method:

The ejection time (ET) is measured with pulsed Doppler of RV outflow (time from the onset to the cessation of flow), and the tricuspid (valve) closure-opening time is measured with either pulsed Doppler of the tricuspid inflow (time from the end of the trans-tricuspid A-wave to the beginning of the trans-tricuspid E wave) or continuous Doppler of the TR jet (time from the onset to the cessation of the jet). These measurements are taken from different images, and one must therefore attempt to use beats with similar R-R intervals to obtain a more accurate (Tei index) value.

Tei index = (tricuspid (valve) closure-opening time – ET)/ET ***(4)***

The upper reference limit is 0.40 by pulsed Doppler ***(5)***.

2- Using Tissue Doppler Method:

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All time intervals are measured from a single beat by pulsing the tricuspid annulus.

Tissue isovolumic contraction time (ICT) will be measured between cessation of A-wave and onset of S- wave. Tissue Doppler ejection time (ET*) will be obtained between onset and cessation of S wave. Tissue Doppler isovolumic relaxation time (IRT) will be obtained between cessation of S-wave and onset of E-wave.

Then estimation of Tei* Index using calculation:

Tei* index = (ICT + IRT)/ET*

Statistical Analysis

was performed using statistical package for the social sciences (SPSS) program version 20 (SPSS, Chicago, IL, USA). Continuous variables were expressed as mean and standard deviation, while categorical variables were expressed as numbers and percentages. Comparison of continuous variables among groups was made using the student's t-test. Associations between two categorical variables were tested using the Likelihood ratio χ 2 test, as appropriate. Statistical correlation between continuous variables was tested using the Pearson's product-moment coefficient of correlation (r).

All tests of significance were two-tailed and a p-value < 0.05 was considered statistically significant. P-value < 0.001 was considered highly statistically significant and p-value ≥0.05 was considered non-statistically significant.

RESULTS

Regarding to demographic data, the present study showed that. No statistically significant differences were found among the groups regarding age and gender

p value > 0.05 (table 1 & 2).

Regarding to risk factor there are significance difference between the two groups in all risk factors (P < 0.01) except for Smoking there was no significant statistical difference(table 4S).

Regarding Dyspnea among HD patients sixty three (56%) patients had dyspnea grade II, forty four (38%) patients had dyspnea grade III, and seven (6%) patients had dyspnea grade IV with a significance of (P<0.001)(table 5S).

Regarding to echocardiography data RV dimensions were significantly larger in HD patients (Basal level – Mid level – Longitudinal length) compared to control group (P < 0.01)) (table 3).

Doppler Tie index was significantly higher in HD patients with mean value of (0.56±0.12) when compared to control group (0.36±0.032) with (P value < 0.001), denoting significantly more depressed RV function in HD patients (table 4).

Tissue Doppler S wave was significantly lower in HD patients with mean value of (8.840±01.149) when compared to control group (14.500±2.945) with (P value < 0.001), denoting significantly more depressed RV function in HD patients(Table 1S).

TAPSE which reflect RV systolic function. Its mean value was significantly lower in HD patients (1.6±0.2) compared to control group (2±0.0) with (P value < 0.001) (Table 2s).

Mean value of FAC was significantly lower in HD patients (35.2±16.5) compared to control group (43.7±6.9) with (P value = 0.01) (Table 3S)

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Table 1. Gender distribution among the study groups

Sex		Patients	Controls	Total
Female	**N**	41	23	64
	%	36.00	36.67	36.25
Male	**N**	73	91	164
	%	64.00	63.33	63.75
Total	**N**	114	114	228
	%	100.00	100.00	100.00
Chi-square	**X^2**	0.004		
	P-value	0.952		

N= Number
P= Probability of chance (significance)
%= Percentage

Table 2. Age distribution among the study groups

Groups	Age						T-test	
	Range			Mean	±	SD	t	P-value
Patients	29	-	52	41.040	±	5.507	-1.058	0.293
Controls	34	-	54	42.400	±	5.661		

SD= standard deviation
t= T test

Table 3. Comparison between the study groups regarding Right side dimensions

		Groups						T-test	
		Patients			Controls			T	P-value
Basal	**Range**	**2.000**	**-**	**4.200**	**2.200**	**-**	**2.600**	**7.788**	**<0.001***
	Mean±SD	**3.150**	**±**	**0.515**	**2.407**	**±**	**0.108**		
Mid	**Range**	**3.100**	**-**	**4.900**	**2.800**	**-**	**3.200**	**11.229**	**<0.001***
	Mean±SD	**3.924**	**±**	**0.442**	**2.990**	**±**	**0.135**		
Longitudinal	**Range**	**5.600**	**-**	**8.800**	**5.900**	**-**	**6.200**	**11.146**	**<0.001***
	Mean±SD	**7.476**	**±**	**0.722**	**5.997**	**±**	**0.089**		

Table 4. Comparison between the study groups regarding Doppler Tie index

Groups	Doppler Tie index						T-test	
	Range			Mean	±	SD	T	P-value
Patients	**0.3**	**-**	**0.8**	**0.564**	**±**	**0.128**	**8.544**	**<0.001***
Controls	**0.3**	**-**	**0.4**	**0.360**	**±**	**0.032**		

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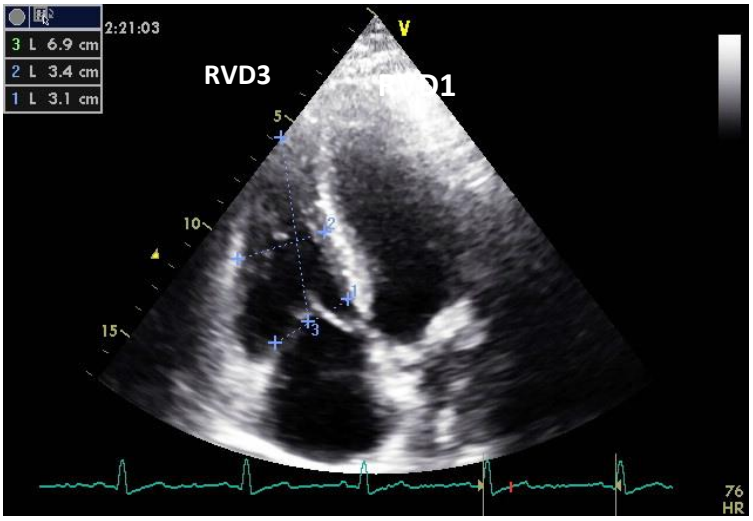

Figure 1. Apical 4-chamber image showing the right ventricular (RV) basal (1L) and mid cavity (2L) and the RV longitudinal dimension (3L).

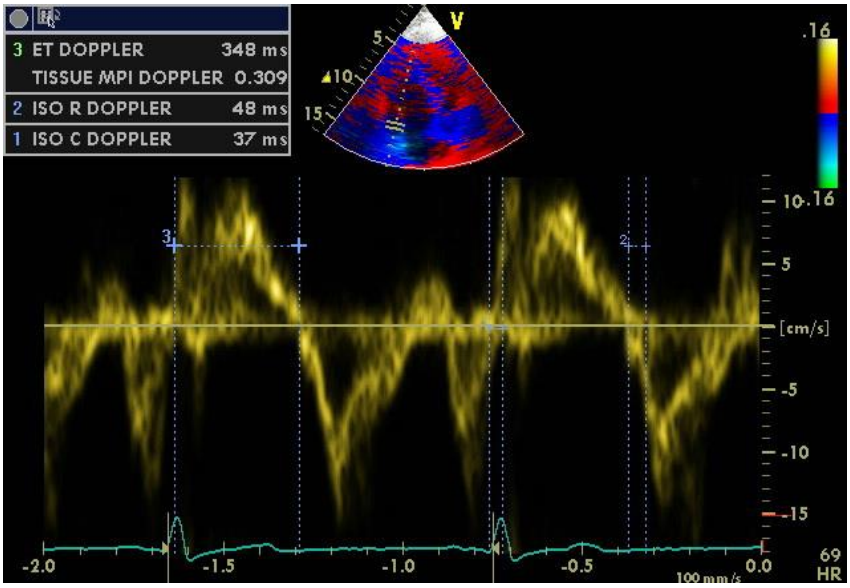

Figure 2. Measurement of ET* (ET Doppler), ICT (ISO C Doppler) and IRT (ISO R Doppler)

DISCUSSION

Cardiovascular disease is the prominent cause of morbidity and mortality in dialysis patients, being responsible for almost 50% of deaths and nearly 40% of hospitalizations ***(7)***. In particular, congestive heart failure is the most common finding in these patients and is associated with poor prognosis ***(8)***.

Hemodialysis (HD) which is usually carried out via a surgically created native arterio-venous fistula (AVF) has been associated with an increased risk of pulmonary hypertension ***(9)***. In HD patients, AVF causes a left-to-right shunt leading to chronic volume overload, independently of the increase in total body water, thus worsening right ventricular overload ***(10)***.

Previous studies regarding the relation between pulmonary hypertension and dialysis have mostly investigated the impact of volume

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overload on TDI indices of left ventricular function, showing an increased prevalence of diastolic dysfunction in these patients ***(11)*** However, most available studies focused their attention on left ventricular function in dialysis patients ***(12)***. The impact of dialysis treatments on the development of RVD has not fully been investigated. But recently a retrospective study in which ***(13)*** investigated the impact of different dialysis treatments on right ventricular function showed that HD increases the risk of RVD, particularly in the presence of brachial AVF.

The existing qualitative parameters for assessment of right ventricular function have some limitation. However, right ventricular fractional area change (FAC) may be useful as an estimation of right ventricular global function and Tricuspid systolic annular motion (TAPSE) may provide a simple method for global RV systolic functional assessment. Although, these techniques have some limitations due to difficult RV geometry. particularly in patients with distorted right ventricular shape ***(14)*.**

The present study was a *prospective* study that was designed to investigate the impact of chronic dialysis therapy on right ventricular function. It included 228 patients, 114 patient with ESRD on regular Hemodialysis and 114 as a control group with normal renal functions.

In the present study both systolic and diastolic blood pressure were significantly higher in patients with ESRD than controls, This finding was similar to the study of (***15)*** who found that ESRD patients had significantly higher blood pressure than controls.

In this study patients with ESRD were more symptomatic regarding dyspnea than controls, and this was in agreement with (***16)*** who did a meta analysis of randomized controlled trials in pulmonary hypertension patients total of 3140 patients in period between Jan 1990 to October 2008 and found that patients with pulmonary hypertension were more symptomatic regarding dyspnea.

In the present study we found increase right ventricular wall thickness in patients with ESRD than controls, and this in agreement with a study carried by (***17)*** which used RV wall thickness as a one of the parameters to assess right ventricular functions in patients with increased pulmonary pressure as an indicator of pressure overload.

Right ventricular fractional area change is a measure of RV systolic function that has been shown to correlate with RV ejection fraction by magnetic resonance imaging (MRI) ***(18)***. In our study we found that RV FAC was significantly lower in patients with ESRD than controls, Our study found that the prevalence of reduced FAC *(less than 35% according to the definition by American Society of Echocardiography Guidelines for the Echocardiographic Assessment of the Right Heart in Adults 2010) was* ***48% (55 patients)***., Study conducted by (***19)*** showed statistically significant decrease in RV FAC in patients of HD compared with control.

The TAPSE is good parameter to evaluate the right ventricle function and it correlates closely with RVEF and RV fractional area change in a variety of patient populations ***(20)***, Our study found that the prevalence of reduced TAPSE *(less than 1.6 cm (according to the mean lower limit of TAPSE defined by American Society of Echocardiography Guidelines for the Echocardiographic Assessment of the Right Heart in Adults 2010) was* ***40% (45 patients)***. There are few recent studies that measured the TAPSE in chronic HD as (***21)*** study which shows significantly lower TAPSE in patients with ESRD with AVF after HD more than patients with permanent central venous catheter and normal controls.

In the present study there was a highly significant difference in measurement of Tie index (assessed by conventional Doppler and Tissue Doppler) between patients with ESRD on HD and controls with a prevalence of abnormal Tie index by conventional Doppler was **76% (87 patients)** and prevalence of abnormal Tie index by tissue Doppler was **80% (91 patients),** which agreed with the data by ***(22)*** who examined patients with pulmonary hypertension and found that Tie index by TDI

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is significantly superior than conventional Doppler in assessment of RV Tie index because Tissue Doppler reflect functional status of the myocardium directly.

According to the mean lower limit of lateral TDI S wave (less than 10 cm/sec)there were **84% (96 patients)** who had abnormal decrease of lateral TDI S wave.

Our study showed that patients with HD had statistically significant lower lateral TDI S wave compared to controls. This finding was similar to the study conducted by (***23)*** that showed significant decrease in lateral and septal tricuspid annular systolic excursion in HD Vs controls.

Study Limitations

- Small number of patients in the study.
- Exclusion criteria which used in study protocol rolled out many variables that may affect RV function.
- Cardiac Magnetic resonance (MRI) not used to asses RV function to be compared with echocardiography results.
- The lack of follow up of HD patients with right ventricular dysfunction did not give the chance to know the prognosis.

CONCLUSION

Myocardial Performance index (tie index) and S wave measured by tissue Doppler are simple and quick parameters that can used in HD patients to asses global right ventricular function with good accuracy .Both parameters not affected by right ventricular geometry and have the advantage of simultaneously recording both systolic and diastolic velocity patterns in the same cardiac cycle.

Conflict of Interest: Nothing to declare.

Financial Disclosures: Nothing to declare.

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