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Assessment of Left Ventricular Diastolic Dysfunction by 2D Speckle Tracking in Hemodialysis Patients

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ABSTRACT

Background: Diastolic dysfunction is widespread among patients on dialysis and is associated with increased morbidity and mortality. Echocardiographic speckle tracking strain rate analysis may allow assessment of left ventricular diastolic function.

Objectives: The purpose of this study was aimed to test the capability of speckle tracking diastolic strain rate to assess the clinical and subclinical left ventricular diastolic dysfunction in end stage renal disease patients who are on dialysis.

Subjects and Methods: This prospective study included a total of 45 subjects, 30 of them were on dialysis, attending at the Outpatient Clinic, Department of Cardiology, Faculty of Medicine, Al-Azhar University Hospital and Nasr City Police Hospital. The included subjects were divided into three groups; **Group (A)** included fifteen healthy control subjects, Group **(B)** included fifteen patients with dialysis with normal diastolic function and **Group (C)** included fifteen patients with dialysis with diastolic dysfunction.

Results: No significant differences were observed between control subjects and study population as regard age, sex, DM, smoking and Dyslipidemia. In the current study, comparison between the three groups revealed statistically significant difference in mean values of HTN. Comparison between the three groups revealed highly statistically significant differences in echocardiographic parameters that included E/A, E/e, LA volume, TR velocity and speckle tracking diastolic strain rate used in evaluation of Diastolic function " P value 0.001 ".

Conclusion: Two-dimensional speckle tracking could be used in assessment of diastolic dysfunction among people on dialysis dependent on speckle tracking diastolic strain rate.

Keywords: Left Ventricular Diastolic Dysfunction, Two-Dimensional Speckle Tracking Echocardiography, dialysis patients.

INTRODUCTION

In dialysis patients, both cardiovascular and non-cardiovascular mortality are significantly increased as compared to the general population [(1)]. In particular, cardiovascular mortality contributes to 40% of all-cause mortality in these patients, mainly due to sudden cardiac death [(2)].

Several parameters, such as left ventricular hypertrophy (LVH) and left ventricular (LV) systolic dysfunction, have been identified as independent predictors of cardiovascular outcome in dialysis patients. Next to that significant diastolic heart dysfunction, as assessed by tissue Doppler imaging (TDI), has also demonstrated significant incremental prognostic value for all-cause mortality and cardiovascular death [(3)].

Similar to the general population, diastolic heart failure in dialysis patients often exists without the presence of significant systolic heart failure [(4, 5)]. Therefore, accurate evaluation of LV diastolic dysfunction is crucial in the management and risk stratification of dialysis patients, especially in those with preserved ejection fraction. Particularly, LV diastolic function and its determinants might represent an important target for therapeutic options aimed at improving the abysmal prognosis of this group of dialysis patients with preserved ejection fraction.

The aim of the current work was to observe the relationship between left Ventricle (LV) spickle tracking diastolic strain rate and left ventricular diastolic function in hemodialysis patients. In addition to determine whether LV spickle tracking diastolic strain rate could be used to detect diastolic dysfunction (DD).

SUBJECTS and METHODS

This prospective study included a total of 45 subjects, 30 of them were on dialysis, attending at the Outpatient Clinic, Department of Cardiology, Faculty of Medicine, Al-Azhar University Hospital and Nasr City Police Hospital. This study was conducted between January 2019 and September 2019.

Ethical approval and written informed consent :

The study was approved by the Medical Ethics Committee of Al-Azhar University Academic and Ethical Committee and a written informed consent was obtained from all patients.

The included subjects were divided into three groups; **Group (A)** included fifteen healthy control subjects, Group **(B)** included fifteen patients with dialysis with normal diastolic function and **Group (C)** included fifteen patients with dialysis with diastolic dysfunction.

Inclusion criteria

- The patient with LV ejection fraction (EF) ≥55%,

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- Normal sinus rhythm
- No significant valvular heart disease (defined as greater than mild regurgitation or stenosis) or a prosthetic valve.

Exclusion criteria

- Refusal of the patients to participate in the study.
- If images were of poor quality.
- If image loops did not depict all LV segments, did not allow speckle tracking of atrial boundaries (<15% of the patients), which might preclude accurate strain measurements.
- Associated other congenital heart disease.
- Previous cardiac surgical or percutaneous cardiac interventions.
- Patients with rhythm other than sinus rhythm, pacemaker, ongoing arrhythmia.
- Patients with reduced EF ≤ 55%.

All patients included in the study were subjected to the following:

- Thorough history taking.
- Complete clinical examination.
- Full general examination including cardiological, chest, and abdominal examination.

Patients underwent 2D transthoracic echocardiography with assessment of:

- Left ventricular ejection fraction (LVEF).
- Left ventricular fraction shortening (LVFS)
- Left ventricular end-diastolic volume (LVEDV).
- Left ventricular end-systolic volume (LVESV).

Diastolic dysfunction was assessed by:

- E\A wave by PW on mitral valve in A4C view.
- E\e as e obtained from TDI average of septal and lateral mitral valve annulus in A4C.
- LA volume as it obtained from A4C and A2C views.
- TR Velocity as it obtained from A4C view with CW through TV.
- Left ventricular diastolic free wall strain rate in rapid filling phase (early peak diastolic) by using 2D speckle tracking imaging in A2C, A3C and A4C.

Statistical analysis

The recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

The following tests were done:

- Independent-samples t-test of significance was used when comparing between two means.
- Chi-square (x^2) test of significance was used in order to compare proportions between two qualitative parameters.
- The confidence interval was set to 95% and the margin of error accepted was set to 5%. The p-value was considered significant as the following:
- Probability (P-value)
  - P-value <0.05 was considered significant.
  - P-value <0.001 was considered as highly significant.
  - P-value >0.05 was considered insignificant.

RESULTS

Table (1): Comparison between the three groups revealed statistically non-significant difference in mean values of Sex

Sex		Control	Group B	Group C	Total
Male	**N**	8	8	7	23
	%	53.3%	53.3%	46.7%	51.1%
Female	**N**	7	7	8	22
	%	46.7%	46.7%	53.3%	48.9%
Total	**N**	15	15	15	45
	%	100.0%	100.0%	100.0%	100.0%
Chi-square	**X^2**	**0.178**			
	P-value	**0.915**			

*Comparison between the three groups revealed statistically non-significant difference in mean values of Sex

Table (2): Comparison between the three groups revealed statistically non-significant difference in mean values of Smoking

Smoking		Control	Group B	Group C	Total
Yes	N	2	3	2	7
	%	13.3%	20.0%	13.3%	15.6%
No	N	13	12	13	38
	%	86.7%	80.0%	86.7%	84.4%
Total	N	15	15	15	45
	%	100.0%	100.0%	100.0%	100.0%
Chi-square	X^2	0.338			
	P-value	0.844			

* Comparison between the three groups revealed statistically non-significant difference in mean values of Smoking

Table (3): Comparison between the three groups revealed statistically non-significant difference in mean values of DM

DM		Control	Group B	Group C	Total
Yes	N	2	3	3	8
	%	13.3%	20.0%	20.0%	17.8%
No	N	13	12	12	37
	%	86.7%	80.0%	80.0%	82.2%
Total	N	15	15	15	45
	%	100.0%	100.0%	100.0%	100.0%
Chi-square	X^2	0.304			
	P-value	0.859			

***** Comparison between the three groups revealed statistically non-significant difference in mean values of DM

Table (4): Comparison between the three groups revealed statistically non-significant difference in mean values of Dyslipidemia

Dyslipidemia		Control	Group B	Group C	Total
Yes	N	2	3	3	8
	%	13.3%	20.0%	20.0%	17.8%
No	N	13	12	12	37
	%	86.7%	80.0%	80.0%	82.2%
Total	N	15	15	15	45
	%	100.0%	100.0%	100.0%	100.0%
Chi-square	X^2	0.304			
	P-value	0.859			

*Comparison between the three groups revealed statistically non-significant difference in mean values of Dyslipidemia

Table (5): Comparison between the three groups revealed statistically significant difference in mean values of HTN

HTN		Control	Group B	Group C	Total
Yes	**N**	3	9	9	21
	%	20.0%	60.0%	60.0%	46.7%
No	**N**	12	6	6	24
	%	80.0%	40.0%	40.0%	53.3%
Total	**N**	15	15	15	45
	%	100.0%	100.0%	100.0%	100.0%
Chi-square	**X^2**	**6.429**			
	P-value	**0.040***			

* Comparison between the three groups revealed statistically significant difference in mean values of HTN

Table (6): Comparison between the three groups revealed statistically highly significant difference in mean values of Echocardiography

		Range	Mean ± S. D	F. test	p. value		
EF	**Control**	58 – 75	65.40 ± 4.64	6.582	0.003*	P1	0.008*
	Group B	57 – 70	61.33 ± 4.17			P2	0.001*
	Group C	56 – 65	60.40 ± 3.07			P3	0.528
FS	**Control**	29 – 43	33.87 ± 3.23	8.867	0.001*	P1	0.002*
	Group B	28 – 35	30.93 ± 2.15			P2	0.001*
	Group C	27 – 33	30.33 ± 1.76			P3	0.508
E/A	**Control**	1.3 – 1.6	1.41 ± 0.10	29.868	0.001*	P1	0.001*
	Group B	0.9 – 1.3	1.11 ± 0.14			P2	0.001*
	Group C	0.5 – 1.4	0.87 ± 0.29			P3	0.001*
E/e	**Control**	6 – 9	7.40 ± 1.06	111.859	0.001*	P1	0.002*
	Group B	7 – 11	9.27 ± 1.03			P2	0.001*
	Group C	12 – 20	15.67 ± 2.32			P3	0.001*
LA volume	**Control**	18 – 33	26.00 ± 4.28	205.494	0.001*	P1	0.001*
	Group B	40 – 51	46.40 ± 3.60			P2	0.001*
	Group C	50 – 65	56.00 ± 4.49			P3	0.001*
TR velocity	**Control**	0.4 – 0.9	0.67 ± 0.15	811.301	0.001*	P1	0.001*
	Group B	1.2 – 1.8	1.59 ± 0.17			P2	0.001*
	Group C	2.8 – 3.2	2.95 ± 0.14			P3	0.001*
STI sr	**Control**	1.3 – 1.7	1.51 ± 0.11	300.972	0.001*	P1	0.001*
	Group B	0.8 – 1.1	1.00 ± 0.10			P2	0.001*
	Group C	0.3 – 0.7	0.53 ± 0.12			P3	0.001*

P1: Control & Group B **P2: Control & Group C** **P3: Group B & Group C**

*Comparison between the three groups revealed statistically highly significant difference in mean values of Echocardiography

DISCUSSION

In the current study, comparison between the three groups revealed statistically significant differences in mean values of HTN, while the difference in mean values of DM was insignificant. In the current study, comparison between the three groups revealed statistically significant difference in HTN (20%) of the control group with Normal DD, (60%) of patient on dialysis with normal DD by conventional Echo and (60%) of patients on dialysis with DD by speckle tracking " P value 0.040 ".

In the current study, comparison between the three groups revealed highly statistically significant echocardiographic parameters which include E/A, E/e, LA volume and TR velocity used in evaluation of Diastolic function among the three groups including normal and dialysis patients " P value 0.001 "

We had evaluated clinically 45 Egyptian subjects and divided them into three major groups, control and dialysis cases. They were subjected to detailed echocardiographic examinations of the LV diastolic function. This study was a prospective study in which the patients were classified according to clinical and echocardiographic findings into three groups:

***Group A (control group)*:** includes 15 subjects with normal diastolic function by conventional echocardiography which represent 33.5% of studied patients.

***Group B (patient group)*:** includes 15 patients on dialysis with normal diastolic function by conventional echocardiography which represent 33.5% of studied patients.

***Group C (patient group)*:** includes 15 patients on dialysis with diastolic dysfunction by conventional echocardiography which represent 33.5% of studied patients.

The groups were homogenous as there was no statistically significant difference as regard age (22_38 years), sex, dyslipidemia, diabetes mellitus and smoking. These results were in agreement with the findings of **Júnior *et al.*** [6] who studied relationship between diastolic function by conventional Echo and speckle tracking strain rate using 81 patients and divide them in 2 groups according to LVEDP (group (A) 41 patients <16 mm Hg and group (B) 40 patients > 16 mm Hg), but age was more than 50 years and 33% were females but there was no significant difference between 2 groups.

These findings were not agree with those of **de Bie *et al.*** [7] however this study talked about speckle tracking diastolic function in hemodialysis patients which included 77 patients on dialysis and all of them were investigate 1 day before dialysis but most of patients were old age (55-80 years) , most of them were males 74% and there was significant P value in DM, but this study not talked about smoking and dyslipidemia, in addition to it, it also study the eff ect of prophylactic implantable cardioverter defibrillator (ICD) in chronic dialysis patients.

There was statistically significant differences between the groups (Control and dialysis) in hypertension and all echocardiographic parameters including LVEF, E/A, E/e, LA volume, TR velocity , speckle tracking strain rate in rapid filling phase of diastole.

These findings (LVEF,E/A, E/e,LA volume) were in agreement with the findings of **de Bie *et al.*** [7] this study evaluates diastolic function in these patients by using conventional Echo and speckle tracking diastolic function strain rate but it was in SRIVR as the following (devide *E/*SRIVR and it was significant when this ratio more or equal 236 it mean there is diastolic dysfunction because when the strain rate decrease it mean impaired relaxation of LV and this lead to increase ratio), but this study also used deceleration time (DT) as a parameter of diastolic dysfunction and not used TR velocity as my study in addition to it, it also study the eff ect of prophylactic implantable cardioverter defibrillator (ICD) in chronic dialysis patients (age 55–80 years) .

These findngs (E/e`,LA volume ,TR velocity) were also in agreement with the findings of **Júnior *et al.*** [6] who demonstrated a great statistical significance between two groups and also high statistical significance in E and A wave but no statistical difference in E/A ratio .

In this study no significant differences in speckle tracking strain rate, however all statistical strain rate obtained as following GLSRE (early-diastolic or E peak), and GLSRA (late- diastolic or A peak) and SR also obtained from parasternal short axis at levels of (basal, medial, and apical). Also, no significant difference in all these ratios E/GLSRE ,E/GLSRA, E/GCSRE, the only significant ratio was E/GCSRA. (GCSR = global circumferential strain rate; GLSR = global longitudinal strain rate).

These findings (E/A, E/e`, LA volume) were also in agreement with the finding of **Malik *et al.*** [8] this study include 46 patients on dialysis and applying American L/ European guidelines to assessment of LV diastolic function in these patients, about 53% were LVH and about 61% already had diastolic dysfunction of grade I, II, III. There was strong relationship between BNP and diastolic dysfunction. In this study there was no significant differences in EF, HTN and TR velocity. Also, there was significant difference between these patients before and after hemodialysis in BP, HR, E/A and huge significant different in LA volume.

These findings (E/A, E/e`, STEsr) were also in agreement with the finding of **van Grootel *et al.* (9)** this study include 147 healthy patients it study relation between age , sex and diastolic function it divided into 5 groups according to age each group more than 28 subject and have equal in sex (group 1,2,3,4,5__ 20-29,30-39,40-49,50-59,60-69 respectively) and it found that diastolic dysfunction increase with age and males P value was highly significant in E/A ratio and STEsr and significant in E/e`. But not significant LA volume and HTN patient were excluded from the study.

In the study of **Hamidi *et al.* (10)** which included 25 patients and assessed its diastolic dysfunction before and after 1 month of renal transplantation by conventional Echo and STEsr which revealed significant improvement of in diastolic function after renal transplantation by STEsr in A4C view.

Pecoits-Filho *et al.* (11) in their article about diastolic dysfunction in hemodialysis patients (because dialysis increase incidence of heart failure with preserved ejection fraction) and how to assessment by conventional Echo as the following parameter :

1) In patients with DD grade I (impaired relaxation), the mitral E⁄ A ratio is <0.8, the E⁄ e¢ ratio is <8 (average septal and lateral), and LAVi can be normal or mildly increased.

2) In patients with DD grade II (pseudo normalization) the mitral E⁄ A ratio between 0.8 and 2 , E⁄ e¢ ratio between 9 and 12, and LAVi > 34 ml ⁄m2

3) In patients with severe DD grade III restrictive LV filling arises, with an E⁄ A ratio > 2, A mitral flow duration shorter than Ar pulmonary venous flow duration, eaverage E⁄ e¢ ratio > 13 (or septal E⁄e¢ > 15), and LAVi > 34 ml⁄m2 (often >40 ml⁄m2).

CONCLUSIONS

It could be concluded that in dialysis patients with preserved LVEF, the prevalence of LV diastolic dysfunction assessed by global LV SR is relatively high and might be underestimated when using conventional echocardiographic techniques.

RECOMMENDATIONS

Speckle tracking diastolic strain rate could be used in assessment of sub clinical DD regarding dialysis patients for early diagnosis of DHF in these patients.

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