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Monocyte to lymphocyte ratio as a predictor of left ventricular hypertrophy in end stage renal disease patients underlying hemodialysis

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Abstract
Background: Left ventricular hypertrophy (LVH), that may be seen in a vast majority of individuals at the beginning of dialysis and is closely connected with the severity of renal insufficiency, is the most prevalent cardiac abnormality in ESRD, Monocyte/lymphocyte ratio (MLR) is one of the most sensitive predictor of cardiovascular disease (CVD) events. In individuals on dialysis that are prone to asymptomatic and symptomatic infections, MLR is also an indicator of infectious problems. This study's objective was to assess MLR as a predictor of LVH in ESRD Patients on hemodialysis (HD).
Methods: The cross-sectional work was performed on 100 adults of end stage renal disease individuals receiving dialysis, both sexes participants were categorized into two groups: group I consists of 66 individuals who were diagnosed by ECHO during study to have LVH, group II included 34 patients who were diagnosed by ECHO during study not to have LVH.
Results: Echocardiographic parameters had revealed statistically significant increase in group 1 than group 2 as regards left ventricle end systolic disease (LVESD), left ventricle end dyastolic disease (LVEDD), EF, E/e′, interventricular septum (IVS), Posterior Wall Thickness (PWT), Relative wall thickness (RWT), and left ventricular mass index (LVMI). MLR was positively correlated with duration of HD, urea post dialysis, LVEDD, LVESD, left atrial dimensions (LAD), IVS, PWT, E/e′, and LVMI and negatively correlated with urea reduction ratio, systolic blood pressure post dialysis, and diastolic blood pressure post dialysis according to M/L ratio for detection of HD patients with LVH: The regression analysis revealed monocyte to lymphocyte ratio to be a good predictor of LVH in patients with ESRD on HD. At cut off value of 0.148; area under the curve was 0.785, the sensitivity was 93.93%, specificity was 85.3%, positive predictive value (PPV) was 92.53%, and negative predictive value (NPV) was 87.87%.
Conclusions: Monocyte to Lymphocyte ratio is a good, readily accessible and widespread marker for detection of LVH in ESRD patients undergoing HD.

Keywords: Monocyte lymphocyte ratio, left ventricular hypertrophy, end stage renal disease, hemodialysis

Introduction
Chronic kidney disease (CKD) is a complicated disorder that occurs when the kidneys' inability to perform their normal functions causes excess fluid and waste to accumulate up in the bloodstream [1]. CKD places a significant financial strain on the world's healthcare systems [2].Today, there are a lot more people who have CKD. Between 11% and 13% of the world's population is thought to be impacted [3].
Left ventricular dysfunction (LVDys) is prevalent in the hemodialysis (HD) people, occurring at a rate 10–30 times higher than in the general population. With a documented 3-year survival rate of just 17%, a medical diagnosis of congestive heart failure (CHF) in the HD populations substantially correlated with mortality [4].This increased risk, that appears to be driven by the so-called nontraditional risk factors linked to CKD, is not entirely explained by the conventional risk variables associated with cardiovascular diseases. A greater incidence of ventricular hypertrophy, fibrosis in myocardium, valvopathies, arrhythmias, and sudden cardiac death are also linked to this group of risk factors, which accelerate the progression of coronary artery disease (CAD) [5]. The major cause of mortality in people with end-stage renal disease (ESRD) is cardiovascular illness.

These people have a 40% greater than the average incidence of CAD than the overall population. Individuals on HD with peritoneal dialysis are thought to have cardiovascular deaths at a rate of 9% year [6]. Left ventricular hypertrophy (LVH), that was seen in 75% of the individuals at the beginning of dialysis, is the most frequent cardiac abnormality in ESRD [5-6].

The severity of renal insufficiency affects the incidence of LVH [7]. LVH is a concerning prognostic indication that increases the risk of sudden cardiac death, arrhythmias, heart failure, and myocardial ischemia [8, 9]. It may cause diastolic and/or systolic dysfunction. Monocytes are widely recognised for being a major player in the aetiology of atherosclerosis and for playing a significant part in inflammation. In addition to increased baseline generation of cytokines and reactive oxygen species (ROS), individuals who have ESRD show an overall increase of circulating monocytes, which contributes to the population's predominate systemic inflammation and oxidative stress [10]. On the contrary hand, this type of spontaneous activation is accompanying by reduced monocyte phagocytic ability [11]. as well as compromised antigen presentation ability [12], which results in defective T and B cell functions. This phenomenon is also aided by the impaired expression of co-stimulatory molecules [13].

Epidemiological studies' results show that cardiovascular and all-cause mortality in individuals with HD are independently correlated with higher monocyte counts [14].

This study aimed to determine if the monocyte/lymphocyte ratio was a reliable indicator of LVH in ESRD patients using HD.

Patients and Methods

This cross-sectional work was performed on 100 adults of end stage renal disease (ESRD) individuals on dialysis, both sexes. The patients were attendees of HD and Nephrology Unit, Internal Medicine Department, Tanta university hospitals in the period between August 2021 to April 2022. The Quality Assessment Unit in the Faculty of Medicine of Tanta University conducted the research with permission from the Ethical Committee, using the hospital's resources and conducting it there. Each individual received informed written permission after a thorough discussion of the advantages and risks.

Exclusion criteria were individuals below 18 years, having valvular heart disease, with documented rheumatic heart disease, and women during pregnancy.

Participants have been separated into two categories: group I consisted of 66 individuals who were diagnosed by ECHO during study to have LVH, group II included 34 patients who were Each participant had a thorough taking of history, thorough physical examination, and laboratory testing [CBC, kidney function tests, electrolytes (Calcium and phosphorus), and virology screen (HBs Ag, HCV Ab and HIV Ab), parathormone hormone].

Blood sampling and processing: 8 ml of venous blood specimen was taken following a quality assurance and safety method in standard vacutainer tubes. For the CBC test, 2 ml had been added to the EDTA. Centrifugation at 3000 rpm for 15 minutes was used to separate the serum from the remaining 6 ml of blood for all specimens. serum sample for assayed for urea, creatinine, calcium, phosphorus, parathormone hormone, HBs Ag, HCV Ab and HIV Ab.

Echocardiography

A GE vivid seven cardiac ultrasound phased array system with tissue Doppler imaging employing an M4S transducer 4 MHz was used for all experiments. Doppler flow measures in two dimensions, M-mode, and tissue Doppler flow were all part of the conventional echocardiographic examination. The parasternal long-axis view was used to evaluate the diastolic posterior wall thickness (PWT), diastolic interventricular septum thickness (IVS), left atrial (LA) diameter, and left ventricle end diastolic (LVEDD) and end systolic dimensions (LVESD).

Treatment: erythropoietin 4000 I.U. for subcutaneous or intravenous injection: dose different from patient to patient according to hemoglobin level and weight of patient, L-carnitine 1 gm/5 ml ampoule for slow intravenous injection: one ampoule weekly for all patients.

Statistical analysis

The IBM SPSS software programme, version 23.0 (SPSS Inc., Chicago, IL, USA), was used to analyse the data. Numbers and percentages were used to characterise the qualitative variables, and the Chi-square test was used to compare them. For numerical variables with a distribution that is normal, the quantitative parameters were reported as mean and standard deviation and contrasted using the Student's t-test; for numerical variables with an abnormal distribution, median and interquartile range (IQR) were contrasted using the Mann Whitney test. The normality of the distribution was examined using the Kolmogorov-Smirnov test. Correlation between variables: analyzed using Pearson and Spearman's rho method. To account for covariates, univariate and multivariate logistic regression analyses were employed. The capacity of factors to differentiate between certain patient groups was compared using the receiver operating characteristic curve (ROC). Significance of the obtained results was considered at p-value ≤ 0.05.

Results

There was insignificant variation was existed among group 1, and group 2 as regard age, and sex distribution (P-value > 0.05). While a statistically substantial increase was existed among group 1 and group 2 as regard HD duration, DM, DM/smoking, HTN, HTN/smoking, HTN/DM, smoking and blood flow (p-value ≤ 0.05). Table 1.

Table 1: Comparison between all groups under the study regarding sex, age, hemodialysis duration and risk factors

Parameters		Group (1) N%=66%	Group (2) N%=34%	P-Value
Age (Years)				
Mean±SD		60.47±10.62	57.88±10.38	0.248(a)
Hemodialysis duration (Years)				
Median (IQR)		7	3.5	<0.001**(b)
Sex n (%)		(3)	(4)	
Male		41 (73.2%)	15 (26.8%)	0.086(c)
Female		25 (56.8%)	19 (43.2%)	
Male/Female ratio		62.12%/37.87%	44.11%/55.88%	
Risk factors	DM	35 (85.4%)	6 (14.6%)	<0.001**(a)
	DM/Smoking	14 (87.5%)	2 (12.5%)	0.048*(a)
	HTN	43 (79.6%)	11 (20.4%)	0.002*(a)
	HTN/Smoking	12 (92.3%)	1 (7.7%)	0.032*(a)
	HTN / DM	23 (82.1%)	5 (17.9%)	0.034*(a)
	Smoking	17 (85%)	3 (15%)	0.045*(a)

Group 1: Hemodialysis patients with LVH, Group 2: Hemodialysis patients without LVH, DM: Diabetes mellitus, HTN: hypertension n: number, (a): Independent-Sample T Test, (b): Mann-Whitney U, *: Statistically significant at $p \leq 0.05$, **: Highly statistically significant at $p < 0.001$.

There was statistically substantial variation among both groups 1, and 2 as regards treatment with erythropoietin /week (p-value ≤ 0.05). Also, there was insignificant variation among both groups 1, and 2 as regard treatment with L-Carnitine/week, virology and clinical characteristics (p-value > 0.05). Table 2

Table 2: Comparison between all groups under the study regarding erythropoietin, L-Carnitine therapy, virology status, and major complication during hemodialysis:

Parameters	Group (1) No.%=66%	Group (2) No.%=34%	P-Value
Erythropoietin treatment/week			
0	16 (51.6%)	15 (48.4%)	**0.046*(a)**
1	26 (81.2%)	6 (18.8%)	
2	21 (61.8%)	13 (38.2%)	
3	3 (100%)	0 (0%)	
L-Carnitine/week			
1	3 (42.9%)	4 (57.1%)	0.180(a)
2	63 (67.7%)	30 (32.3%)	
Virology			
Negative	46 (63.9%)	26 (36.1%)	0.475(a)
Positive	20 (71.4%)	8 (28.6%)	
Major complication during hemodialysis			0.237(a)
No	45 (60%)	30 (40%)	
Hypertension	14 (87.5%)	2 (12.5%)	
Hypertension	4 (100%)	0 (0%)	
Hypoglycemia	2 (66.7%)	1 (33.3%)	
Itching	1 (50%)	1 (50%)	

n: number, Group 1: Hemodialysis patients with LVH, Group 2: Hemodialysis patients without LVH, (a): Chi-Square Test, *: Statistically significant at $p \leq 0.05$, **: Highly statistically significant at $p < 0.001$

Insignificant variation was existed among both groups 1, and 2 regarding creatinine pre and post dialysis, urea pre dialysis, urea post dialysis, urea reduction ratio in haemodialysis, TLC, platelets, haemoglobin, and absolute monocyte count, absolute lymphocyte count, monocyte (%), and lymphocyte (%) (p-value > 0.05), but a statistically substantial increase was existed among them as regard serum calcium, serum phosphorus, PTH, and monocyte/ lymphocyte ratio (p-value ≤ 0.05). Table 3.

Table 3: Comparison between all groups under the study concerning laboratory data

Parameters	Group (1) No%=66%	Group (2) No%=34%	P-Value
Creatinine pre dialysis (mg/dL)	7.66±0.92	7.54±1.01	0.560(a)
Creatinine post dialysis (mg/dL)	2.71±0.57	2.68±0.57	0.825(a)
Urea pre dialysis (mg/dL)	135.98±23.9	137.21±36.21	0.840(a)
Urea post dialysis (mg/dL)	38.86±9.3	39.74±19.05	0.759(a)
URR (%)	71.13±5.98	71.57±6.47	0.735(a)
Serum calcium (mg/dL)	9.33±0.73	8.96±0.80	0.022*(a)
Serum phosphorus (mg/dL)	5.07±0.78	4.61±0.79	0.005*(a)
PTH (pg/mL) Median (IQR)	252.4 (264.6)	124.5 (63.3)	<0.001**(b)
TLC (10^3/mm3)	7.68±3.69	8.37±2.7	0.341(a)

Platelets (10^3/mm3)	218±77.98	247.68±85.64	0.084[a]
Hemoglobin (g/dL)	9.56±1.91	9.09±1.94	0.404[a]
Absolute Monocyte count Median (IQR)	0.4	0.435	0.258[a]
	(0.3)	(0.4)	
Absolute lymphocyte count (K/µL)	1.62±0.67	1.54±0.44	0.507[b]
Monocyte (%)	5.85±1.955	5.85±1.950	0.998[b]
Lymphocyte (%)	23.64±10.56	20.71±9.49	0.177[b]
Monocyte/ Lymphocyte Ratio	0.353±0.144	0.223±0.094	<0.001**[b]

n: number, PTH: parathyroid hormone, TLC: total leukocytic count Group 1: Hemodialysis patients with LVH, Group 2: Hemodialysis patients without LVH, URR: urea reduction ratio in hemodialysis, (a): Independent-Sample T Test, (b): Mann-Whitney U *: Statistically significant at $p \leq 0.05$, **: Highly statistically significant at $p < 0.001$.

Insignificant variation was existed among both groups 1, and 2 regarding weight pre dialysis, weight post dialysis, dry weight and systolic blood pressure post dialysis, and diastolic blood pressure post dialysis (p-value > 0.05), but a statistically substantial increase was existed among them as regard systolic blood pressure pre dialysis, and diastolic blood pressure pre dialysis (p-value < 0.05). Table 4

Table 4: Comparison between all groups under the study regarding weight pre dialysis, weight post dialysis, dry weight and pre dialysis and post dialysis blood pressure

Parameters	Group (1)	Group (2)	P-Value
	No.%=66%	No.%=34%	
Weight pre dialysis (Kg)	80.7±14.58	81.21±11.99	0.861[a]
Weight post dialysis (Kg)	78.44±16.71	78.43±11.67	0.999[a]
Dry weight	77.76±14.21	78.3±11.69	0.848[a]
Systolic blood pressure pre dialysis (mmHg)	153.03±13.12	137.35±17.63	<0.001**[a]
Diastolic blood pressure pre dialysis (mmHg)	81.82±6.54	84.41±6.12	<0.001**[a]
Systolic blood pressure post dialysis (mmHg)	129.85±18.93	129.71±14.87	0.970[a]
Diastolic blood pressure post dialysis (mmHg)	80.76±8.82	83.24±5.88	0.098[a]

n: number, Group 1: Hemodialysis patients with LVH, Group 2: Hemodialysis patients without LVH, Independent-Sample T Test. *: Statistically significant at $p \leq 0.05$, **: Highly statistically significant at $p < 0.001$.

A statistically substantial increase was existed among both groups 1 and 2 regarding LVEDD, LVESD, EF and E/e′ and blood flow (p-value ≤ 0.05). Insignificant variation was existed among both groups 1, and 2 as regard LAD (p-value > 0.05). but insignificant variation was existed among both groups 1, and 2 as regard number of dialysis session per week, type of shunt or catheter, and type of dialysis filter (*p*-value > 0.05). Table 5.

Table 5: Comparison between all groups under the study as regard LVEDD, LVESD, EF, LAD, E/e′, number of dialysis session, shunt, blood flow, and dialysis filter

Parameters		Group (1)	Group (2)	P-Value
		No%=66%	No%=34%	
LVEDD (mm)		5.42±0.72	4.79±0.66	<0.001**[a]
LVESD (mm)		3.76±0.81	3.15±0.53	<0.001**[a]
EF (%)		66.29±4.44	64.5±3.69	0.047*[a]
LAD		4.02±0.69	3.86±0.63	0.258[a]
E/e′		10.25±0.14	8.12±0.18	<0.001**[a]
IVS		1.19±0.156	0.83±0.153	<0.001**[a]
PWT		1.21±0.158	0.85±0.123	<0.001**[a]
RWT		0.44±0.075	0.35±0.052	<0.001**[a]
LVMI		148.88±43.62	73.69±20.24	<0.001**[a]
Number of dialysis session per week				0.180[a]
2		3 (42.9%)	4 (57.1%)	
3		63 (67.7%)	30 (32.3%)	
Shunt or catheter	Shunt	60 (64.5%)	33 (35.5%)	0.459[a]
	permanent catheter	4 (80%)	1 (20%)	
	mahoker catheter	2 (100%)	0 (0%)	
Blood flow	250	0 (0%)	1 (100%)	<0.001**[a]
	280	3 (100%)	0 (0%)	
	300	30 (93.8%)	2 (6.2%)	
	320	1 (50%)	1 (50%)	
	330	19 (61.3%)	12 (38.7%)	
	350	12 (40%)	18 (60%)	
	360	1 (100%)	0 (0%)	
Dialysis filter				
X 80		60 (65.9%)	31 (34.1%)	0.965[a]
X 100		6 (66.7%)	3 (33.3%)	

n: number, Group 1: Hemodialysis patients with LVH, Group 2: Hemodialysis patients without LVH, LVESD: left ventricular end-systolic diameter, LVEDD: left ventricular end-diastolic diameter, EF: ejection fraction, LAD: left atrial dimensions, E/e′: E wave divided by e′ velocities, (a): Independent-Sample T Test, (b): Chi-Square Test, *: Statistically significant at $p \leq 0.05$, **: Highly statistically significant at $p < 0.001$.

Monocytes/Lymphocytes ratio was positively correlated with duration of HD, urea post dialysis, LVEDD, LVESD, LAD, E/e′, IVS, PWT, and LVMI. Also, Monocytes/Lymphocytes ratio was negatively correlated with URR, systolic blood pressure post dialysis, and diastolic blood pressure post dialysis. While, Monocytes/Lymphocytes ratio was not correlated with age, sex, creatinine pre dialysis, creatinine post dialysis, urea pre dialysis, number of dialysis session, weight post dialysis, weight pre dialysis, dry weight, systolic blood pressure pre dialysis, diastolic blood pressure pre dialysis, serum calcium, serum phosphorus, PTH, EF, and RWT. Table 6.

Table 6: Correlations between monocytes/lymphocytes ratio and demographic, hemodialysis parameters, and echocardiography finding of the patients:

Variables	Monocytes/Lymphocytes ratio	
	r	P
Age	0.038	0.708
Sex	-0.083	0.413
Duration of hemodialysis	0.307	0.002*
Creatinine pre dialysis	0.184	0.067
Creatinine post dialysis	0.110	0.275
Urea pre dialysis	0.130	0.196
Urea post dialysis	0.235	0.018
URR	-0.215	0.032
Number of dialysis session	0.03	0.768
Weight pre dialysis	0.047	0.641
Weight post dialysis	0.059	0.560
Dry weight	0.054	0.597
Systolic blood pressure pre dialysis	-0.001	0.990
Diastolic blood pressure pre dialysis	0.081	0.420
Systolic blood pressure post dialysis	-0.197	0.049*
Diastolic blood pressure post dialysis	-0.249	0.013*
Serum calcium	0.177	0.078
Serum phosphorus	0.01	0.919
PTH	0.043	0.672
LVEDD	0.270	0.006*
LVESD	0.264	0.008*
EF	-0.024	0.810
LAD	0.265	0.008*
E/e′	0.432	0.001**
IVS	0.379	0.001**
PWT	0.375	0.001**
RWT	0.186	0.064
LVMI	0.349	0.001**

*: Statistically significant at $p \leq 0.05$, **: Statistically significant at $p < 0.001$, URR: urea reduction ratio, TLC: total leucocyte count, LVESD: left ventricular end-systolic diameter, LVEDD: left ventricular end-diastolic diameter, LAD: left atrial dimensions, EF: ejection fraction, IVS: interventricular septum, RWT: Relative wall thickness, PWT: Posterior Wall Thickness, LVMI: Left ventricular mass index.

The regression analysis revealed that diastolic blood pressure post dialysis, diastolic blood pressure pre dialysis, monocyte / lymphocyte ratio, and hemoglobin were significantly considered predictors for haemodialysis patients with LVH. Table 7.

Table 7: Regression analysis for predictor factors affecting hemodialysis patients with LVH:

Independent variables	Odds Ratio (95%) CI	P- value
Age	0.957 (0.90 – 1.017)	0.157
Sex	0.490 (0.161 – 1.494)	0.210
Creatinine pre dialysis	1.096 (0.512 – 2.344)	0.813
Creatinine post dialysis	0.860 (0.273 – 2.709)	0.797
Urea pre dialysis	0.952 (0.874 – 1.037)	0.262
Urea post dialysis	1.199 (0.943 – 1.526)	0.139
URR	1.338 (0.932 – 1.920)	0.115
Weight pre dialysis	0.948 (0.652 – 1.379)	0.779
Weight post dialysis	0.690 (0.085 – 5.633)	0.729
Dry weight	1.595 (0.205 – 12.417)	0.656
Systolic blood pressure pre dialysis	1.003 (0.946 – 1.064)	0.908
Diastolic blood pressure pre dialysis	0.818 (0.699 – 0.957)	0.012*
Systolic blood pressure post dialysis	0.983 (0.921 – 1.049)	0.595
Diastolic blood pressure post dialysis	1.211 (1.053 – 1.393)	0.007*
TLC	0.987 (0.838 – 1.163)	0.877
Monocytes	2.009 (0.325 – 12.438)	0.453
Lymphocytes	1.116 (0.452 – 2.757)	0.812

Monocytes (%)	1.003 (0.803 – 1.253)	0.979
Lymphocytes (%)	0.967 (0.914 – 1.022)	0.230
Monocyte / Lymphocyte ratio	0.000 (0.000 – 0.005)	0.001**
Platelets	1.005 (0.998 – 1.012)	0.194
Hemoglobin	1.061 (0.844 – 1.332)	0.614

*: Statistically significant at $p \leq 0.05$, **: Statistically significant at $p < 0.001$.

According to M/L ratio for detection of hemodialysis patients with LVH: at cut off value of 0.148; area under the curve was 0.785, the sensitivity was 93.93%, specificity was 85.3%, positive predictive value (PPV) was 92.53%, and negative predictive value (NPV) was 87.87%.

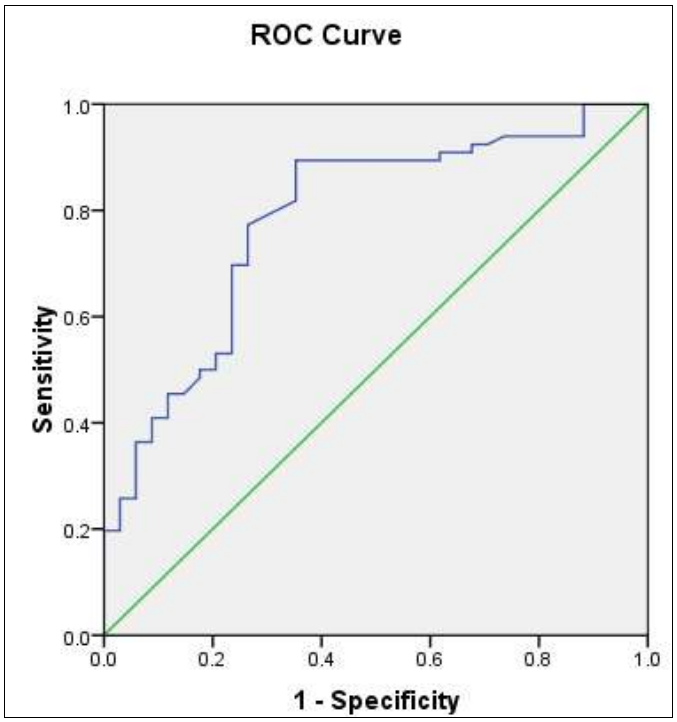

Fig 1: ROC curve for detection of hemodialysis patients with LVH

Discussion

End-stage renal disease (ESRD) individuals most often experience cardiovascular disease (CVD), which accounts for around 50% of all fatalities [15]. The progression of cardiovascular events, including stroke, arrhythmia, LVH, atherosclerosis, and heart failure, is directly correlated with the occurrence of LVH [16].

A statistically substantial increase was existed in group 1 (with LVH) than group2 (without LVH) as regard HD duration (p-value ≤ 0.05). This agreed with Liu *et al*., and Szramowska *et al*., [17, 18] both reported the duration of HD to be increased in LVH than non-LVH group in ESRD patients.

Regarding risk factors (DM, HTN and smoking), reported statistically significant increase in all risk factors in group 1 than group 2 (p-value ≤ 0.05). This disagreed with Szramowska *et al*., [18] who reported that hypertension as a risk factor was not significantly different in both groups.

Regarding, biochemical parameters of both groups, a statistically substantial increase was existed in group 1 than group 2 regarding serum calcium, serum phosphorus, and PTH (p-value ≤0.05).

Liu *et al*., [17] agreed as regard serum calcium and PTH but was in disagreement as regard serum phosphorus also, in agreement with Shaltout *et al*., [19] who had studied the relationship between parathyroid hormone levels and left ventricular mass among individuals with ESRD receiving HD and came to the conclusion that anaemia and hyperparathyroidism are the two main causes of LVH in these individuals.

According to, HD parameters. A statistically substantial increase was existed in group 1 than group 2 as regard pre dialysis systolic blood pressure with (p-value < 0.05) and diastolic blood pressure (p-value <0.05). Also, a statistically substantial increase was existed in blood flow of the machine and erythropoietin therapy in group 1 than group 2 (p-value ≤ 0.05). This finding disagreed with El Badawy *et al*., [20] who studied therapy with recombinant human erythropoietin has an impact on dialysis patients' LVH and heart condition and reported that the use of erythropoietin had reduced cardiovascular morbidity and LVH. The rationale proposed by El Badawy *et al*., [20] was that erythropoietin treatment should correct renal anaemia and cardiac perfusion and so, increase quality of life, decrease morbidity from cardiovascular disease, and increase survival.

On the other hand, erythropoietin treatment can sometimes help increasing blood viscosity by increasing RBCs mass in proportion to plasma. Also, erythropoietin therapy can increase blood pressure and this increase in blood viscosity and blood pressure can subsequently lead to cardiac morbidity and LVH and this proposal can explain results of the present study.

Regarding platelets and haemoglobin, no statistically substantial variation was existed among both groups (p-value ≤0.05). Also, Liu *et al*., [17] did not report any significant changes regarding platelets and haemoglobin between LVH and Non-LVH HD patients.

In view of Echocardiographic parameters, a statistically substantial increase was existed in group 1 (with LVH) than group 2 (without LVH) as regard LVEDD, LVESD, EF, E/e′, IVS, RWT, PWT, and LVMI (p-value ≤0.05).

This agreed with Huang *et al*, and Szramowska *et al*., [21, 22] both reported increase in LVMI in HD patients who developed LVH. The former had studied a MicroRNA-133a detection using a new DSN-based fluorescence assay and its use to diagnose LVH in patients with maintenance HD.

In contrary, the present work disagreed with Cao *et al*., [23] who had studied the relation between BMI, spKt/V and SBP and LVH in Chinese maintenance HD patients and did not report any substantial variation among both groups regarding EF.

Interestingly, the present study had reported increase in MLR in group1 than group2 and correlation was positive with duration of haemodialysis, urea post dialysis, LVEDD, LVESD, LAD, IVS, PWT, E/e′, and LVMI. Also, the regression analysis revealed that monocyte to lymphocyte ratio to be a good indicator of LVH in individuals with ESRD on HD (Sensitivity 93,93% and Specificity 85.3%) with a cut-off value 0.148.

The present study agreed with XIANG *et al*., [24] who conducted research on all-cause and cardiovascular mortality among individuals receiving hemodialysis and

came to the conclusion that a greater MLR was a powerful and independent indicator for all-cause and cardiovascular mortality and outweighed NLR in those receiving HD. but he reported age to be positively correlated to MLR and that finding was not the same in the present study. Also, Muto *et al*., [25] agreed with the present study when he reported that greater MLR is linked to greater chances of CVD events and hospitalisation for infectious diseases in dialysis users. MLR's uses for cardiovascular illnesses, critical illness scores, sepsis, and as a true representative of the inflammatory and immunologic status of the body in different patient populations have drawn increasing amounts of interest in recent years.

Mirna *et al*., [26] who reported strong relationship between MLR and hospital stay duration in patients with was myocarditis. Also, Ji *et al*., [27] had reported that MLR has greater accuracy than NLR and is a good independent risk factor and indicator of the severity of CAD in different groups of cardiovascular disease patients. Despite, the present work had elucidated MLR as s good predictor for LVH in ESRD patients underlying HD and by this way, we can have a new insight for early detection of left ventricular dysfunction in such critical group of patients through a very simple, widely available routine test (CBC and blood smear including differential leucocyte count).

There were some limitations of this study; first, we had only assessed left ventricular dysfunction despite cardiac morbidities in HD patients can include ischemic heart diseases, arrhythmias, and heart failure. Second, since this was a single-center research with a small number of participants (n = 100), statistical strength and external validity may have been compromised. Third, data on other inflammatory markers including IL-6 and TNF-α are missing from this research.

Conclusion

Monocyte to lymphocyte ratio was significantly increased in LVH group of ESRD patients on haemodialysis monocyte to lymphocyte ratio was positively correlated with duration of haemodialysis, urea post dialysis, LVEDD, LVESD, LAD, IVS, PWT, E/e′, and LVMI monocyte to lymphocyte ratio was negatively correlated with urea reduction ratio, systolic blood pressure post dialysis, and diastolic blood pressure post dialysis thus, the present study present evidence that Monocyte to Lymphocyte ratio is a good, readily accessible and widespread marker for detection of LVH in ESRD patients undergoing haemodialysis.

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