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Original Article

Left Ventricular Hypertrophy Patterns in Diabetic Versus Non-Diabetic Hypertensive Patients on Maintenance Hemodialysis in Peshawar

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ABSTRACT

Background: Cardiovascular disease continues to constitute a major source of morbidity and mortality among patients with end-stage renal disease undergoing maintenance hemodialysis, with left ventricular hypertrophy being one of its structural predictors. Hypertension has been established as the important predictor of left ventricular remodeling in these patients, although diabetic patients could have an adverse myocardial phenotype. Objective: To compare the echocardiographic variables and left ventricular geometric patterns of diabetic and non-diabetic hypertensive patients undergoing maintenance hemodialysis in Peshawar, Pakistan. Methodology: This cross-sectional comparative study was conducted on 94 patients with hypertension who were on maintenance hemodialysis for at least three months, with each of the two groups having equal number of patients. Patients in each group were subjected to transthoracic echocardiography 12 to 24 hours after a mid-week dialysis session. Independent-samples t-test and Chi-square analyses were employed to compare left ventricular mass index, relative wall thickness, interventricular septum thickness, posterior wall thickness and left ventricular geometric patterns of patients belonging to the two groups. Results: Diabetic hypertensive patients had a higher left ventricular mass index than non-diabetic hypertensive patients (148.6 ± 22.4 vs 126.3 ± 18.5 g/m^2; p<0.001) as well as relative wall thickness (0.48 ± 0.06 vs 0.42 ± 0.05; p<0.001). Concentric hypertrophy was observed in greater numbers of diabetic hypertensive patients than non-diabetic hypertensive patients (57.4% vs 17.0%), and eccentric hypertrophy was more prevalent in non-diabetic patients (44.7% vs 27.7%). There were significant differences in left ventricular geometry by diabetic status (χ^2=13.064; p=0.004). Conclusion: Diabetic status was associated with higher left ventricular mass index, greater relative wall thickness and concentric hypertrophy in hypertensive patients under maintenance hemodialysis. Longitudinal studies should be done in future to determine the causal relationships involved. Keywords: Cardiomyopathies; Cardiovascular Diseases; Cross-Sectional Studies; Diabetes Mellitus; Heart Failure; Hypertension; Hypertrophy, Left Ventricular; Kidney Failure, Chronic; Pakistan; Renal Dialysis; Ventricular Remodeling.

EDITORIAL INFORMATION

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INTRODUCTION

Chronic kidney disease, evolving to end stage renal disease, is considered a substantial cardiorenal burden, since cardiovascular complications continue to be the main determinants of morbidity and mortality in maintenance hemodialysis (1). In this group, left ventricular hypertrophy is one of the most common and significant manifestations of myocardial structure, resulting from a combination of chronic pressure overload, volume shift, vascular stiffness, anemia, arteriovenous access-dependent high output states, as well as uremic injury (2). Whereas left ventricular hypertrophy can be an initial manifestation of an adaptive process, remodeling in dialysis patients is associated with ventricular dysfunction, heart failure, arrhythmias, sudden cardiac death, and mortality (3).

Hypertension plays an important role in left ventricular remodeling in patients on maintenance hemodialysis; however, the presence of diabetes mellitus might alter the myocardial structure (4). Diabetes leads to myocardial damage via mechanisms independent of systemic blood pressure elevation, such as advanced glycation end product formation, endothelial dysfunction, ischemia, myocardial fibrosis, changes in substrate metabolism, and abnormal diastolic function (5). The simultaneous presence of metabolic disorders in addition to uremia and intradialytic volume fluctuations might result in a more detrimental remodeling phenotype with left ventricular mass index and left ventricular relative wall thickness increase. This becomes clinically significant for the ability to classify the left ventricular geometry as normal geometry, concentric remodeling, eccentric hypertrophy, or concentric hypertrophy (6).

However, in relation to hemodialysis patients, this classification becomes especially important. Eccentric hypertrophy occurs mainly due to volume overload and enlargement of the chamber, while concentric hypertrophy implies an increase in the wall thickness in comparison with cavity volume and is often accompanied by pressure overload, arterial stiffness, and impaired diastolic function (7). Diabetic patients suffering from metabolic myocardial injury may make the development of the pressure-overload phenotype even stronger, thus favoring the development of concentric hypertrophy, which is considered a more adverse pattern with a greater cardiovascular risk compared with eccentric adaptation alone. In this regard, identification of the presence or absence of a different left ventricular geometry in diabetic hypertensive hemodialysis patients and non-diabetic hypertensive hemodialysis patients is useful for proper risk stratification in daily dialysis practice (8).

This issue becomes especially crucial for Pakistan and its largest city Peshawar, where patients with diabetes, hypertension, and end-stage renal disease often come late and are exposed to their cardiometabolic risk factors for a long time, and, moreover, do not have proper cardiovascular surveillance (9). However, despite a large prevalence of diabetes and hypertension among Pakistani hemodialysis patients, there is very little local information about echocardiographic patterns of cardiac remodeling in diabetic and non-diabetic hypertensive dialysis patients. The vast majority of local clinical studies describes only general left ventricular hypertrophy without proper indication of whether the presence of diabetes leads to development of concentric geometry, increase of relative wall thickness, or higher indexed left ventricular mass.

This cross-sectional comparative study, therefore, was conducted to assess echocardiographic characteristics in diabetic and non-diabetic hypertensive subjects on maintenance hemodialysis in Peshawar. The main purpose of this study was to compare the LVMI, RWT, and distribution of left ventricular geometric patterns between the two groups. This study was grounded on the assumption that patients who are hypertensive with diabetes mellitus on maintenance hemodialysis would have more maladaptive left ventricular remodeling, especially concentric hypertrophy, than those patients who are only hypertensive on maintenance hemodialysis.

MATERIAL AND METHODS

This cross-sectional comparative study was carried out during a period of six months from October 2025 to March 2026 in hypertensive patients undergoing maintenance hemodialysis in Peshawar, Pakistan. The purpose of this study was to compare the pattern of LV structural remodeling and LV geometric remodeling in hypertensive patients with end-stage renal disease having diabetes mellitus and non-diabetic hypertension. Cross-sectional design was used because the research objective required the comparison of echocardiographic parameters in various groups at a specific time point during their routine maintenance hemodialysis treatment.

Patients aged 18 to 65 years with end-stage renal disease on maintenance hemodialysis for more than three months and having a diagnosis of systemic hypertension were included in this study. The term maintenance hemodialysis referred to the regular process of hemodialysis done three times a week to replace the function of kidneys. The eligible participants were classified as diabetic hypertensive and non-diabetic hypertensive based upon clinical history, therapeutic management and biochemical profile. Diagnosis of diabetes mellitus was made according to a documented case of diabetes, use of antidiabetic medications or glycated hemoglobin status consistent with the clinical records while non-diabetic patients were those without any documented history of diabetes and biochemical profile showing no diabetes. Hypertension was detected according to the diagnosis, antihypertensive therapy and dialysis unit blood pressure records. Patients with primary valvular heart disease, congenital cardiac disorders and myocardial infarction and inadequate echocardiographic windows were excluded due to potential confounding of structural cardiac anomalies unrelated to hypertensive, uremic or diabetic myocardial remodeling.

Recruitment of study participants was done using non-probability consecutive sampling. Patients who qualified were recruited based on the inclusion/exclusion criteria. There were 94 participants in total, comprising 47 diabetic and hypertensive patients as well as 47 hypertensive but not diabetic patients. A balanced allocation design was chosen to allow comparisons of echocardiographic parameters and left ventricular geometric category among the two groups. Participants' demographic information and clinical history were collected through patient interviews and chart reviews. These data include age, sex, body mass index, dialysis duration, hypertension duration, glycated hemoglobin, and pre-dialysis blood pressure. Measurement of blood pressure was done by sphygmomanometer according to routine dialysis unit procedure.

Transthoracic echocardiography was the main evaluation technique of left ventricular structure and geometry. Echocardiography was done 12-24 hours after mid-week dialysis to rule out the confounding influence of acute volume overload and to allow participants to approach their clinically assessed dry weight as close as possible. All echocardiograms were done by the standard M-mode, two-dimensional, and Doppler echocardiogram views using 3.5 MHz transducer. Left ventricular end-diastolic diameter, left ventricular end-systolic diameter, interventricular septal thickness, and posterior wall thickness were measured. Left ventricular mass was calculated using the Devereux formula and indexed to body surface area to get left ventricular mass index. The ratio of left ventricular end-diastolic diameter to posterior wall thickness was calculated to assess relative wall thickness. The classification of left ventricular geometry was determined based on the left ventricular mass index and relative wall thickness as either normal geometry, concentric remodeling, eccentric hypertrophy, or concentric hypertrophy.

In order to minimize the measurement bias, echocardiography measurement was conducted by one cardiologist without knowing the presence or absence of diabetes in study subjects. The same echocardiographic protocol was adopted in both groups, while all measurements were carried out in the post-dialysis period to make volume status standardized as much as practically feasible. Those patients whose echocardiographic windows were inadequate were excluded from analysis in order to prevent measurement bias. Missing data were checked prior to the statistical analysis, and only those patients whose demographic, clinical and echocardiographic data were complete were retained in the final dataset.

The SPSS version 26.0 was used in statistical analysis. Continuous data were presented as mean ± standard deviation after verifying the distributional assumptions. Categorical data were reported in frequencies and percentages. The Shapiro-Wilk test was employed to check the normality of continuous echocardiographic data. Independent-samples t-test was adopted to compare normally distributed continuous variables between diabetic and non-diabetic hypertensive groups, namely, left ventricular mass index, relative wall thickness, interventricular septal thickness, posterior wall thickness, left ventricular end-diastolic diameter, and left ventricular end-systolic diameter. The Chi-square test was used to compare categorical data such as distribution of left ventricular geometric patterns. If there was a small expected cell count, exact testing was taken into account to be more appropriate. The level of significance was set at <0.05. Since there was difference in duration of hypertension and glycated hemoglobin between groups, the adjusted analysis with clinically relevant covariates such as age, sex, body mass index, dialysis vintage, duration of hypertension and pre-dialytic blood pressure was considered necessary.

The study was carried out with appropriate institutional approval for ethical considerations and followed general standards for human participant studies. The participants were recruited following the consent and the privacy of the participants was ensured throughout the process of data collection, data entry, and analysis. No identifiers were included in the analytic dataset. This study applied standardized methods of data collection, standardized time window for echocardiography, predetermined inclusion criteria, and standardized statistical techniques.

RESULTS

A total of 94 hypertensive patients receiving maintenance hemodialysis were included in the final analysis. The cohort was equally divided into diabetic hypertensive patients (n=47) and non-diabetic hypertensive patients (n=47). Baseline demographic and clinical characteristics are presented in Table 1.

Table 1. Baseline Demographic and Clinical Characteristics of Participants

Variable	Total Sample (N=94)	Diabetic Hypertensive (n=47)	Non-Diabetic Hypertensive (n=47)	Mean Difference	95% CI	p-value
Age (years), Mean ± SD	52.4 ± 7.8	53.8 ± 6.9	51.0 ± 8.4	2.8	-0.35 to 5.95	0.086
Sex, male, n (%)	56 (59.6)	29 (61.7)	27 (57.4)	—	—	0.675
BMI (kg/m²), Mean ± SD	24.8 ± 3.2	25.3 ± 3.5	24.3 ± 2.8	1.0	-0.30 to 2.30	0.138
Dialysis vintage (months), Mean ± SD	28.4 ± 14.1	26.8 ± 12.5	30.0 ± 15.4	-3.2	-8.95 to 2.55	0.274
Duration of hypertension (years), Mean ± SD	8.6 ± 4.3	10.2 ± 4.1	7.0 ± 3.9	3.2	1.56 to 4.84	<0.001
HbA1c (%), Mean ± SD	6.8 ± 1.4	7.9 ± 1.1	5.6 ± 0.4	2.3	1.96 to 2.64	<0.001
Pre-dialytic systolic BP (mmHg), Mean ± SD	154.2 ± 16.5	156.4 ± 17.2	152.0 ± 15.6	4.4	-2.33 to 11.13	0.204
Pre-dialytic diastolic BP (mmHg), Mean ± SD	88.5 ± 9.8	89.2 ± 10.1	87.8 ± 9.5	1.4	-2.62 to 5.42	0.495

Abbreviations: BMI, body mass index; BP, blood pressure; CI, confidence interval; HbA1c, glycated hemoglobin; SD, standard deviation. Mean differences are calculated as diabetic hypertensive minus non-diabetic hypertensive.

Table 2. Comparative Echocardiographic Parameters Between Study Groups

Echocardiographic Parameter	Diabetic Hypertensive (n=47)	Non-Diabetic Hypertensive (n=47)	Mean Difference	95% CI	t	Cohen's d	p-value
	Mean ± SD						
LVEDD (mm)	52.1 ± 4.6	53.8 ± 4.2	-1.7	-3.50 to 0.10	-1.871	-0.39	0.065
LVESD (mm)	35.4 ± 4.1	34.9 ± 3.8	0.5	-1.12 to 2.12	0.613	0.13	0.541
IVST (mm)	12.8 ± 1.4	11.1 ± 1.2	1.7	1.17 to 2.23	6.324	1.30	<0.001
PWT (mm)	12.2 ± 1.3	10.8 ± 1.1	1.4	0.91 to 1.89	5.631	1.16	<0.001
LVMI (g/m²)	148.6 ± 22.4	126.3 ± 18.5	22.3	13.88 to 30.72	5.267	1.09	<0.001
RWT	0.48 ± 0.06	0.42 ± 0.05	0.06	0.037 to 0.083	5.262	1.09	<0.001

Abbreviations: CI, confidence interval; IVST, interventricular septal thickness; LVEDD, left ventricular end-diastolic diameter; LVESD, left ventricular end-systolic diameter; LVMI, left ventricular mass index; PWT, posterior wall thickness; RWT, relative wall thickness; SD, standard deviation.

There were no significant differences regarding age, gender distribution, BMI, dialysis vintage, and pre-dialytic blood pressure between the two groups. Patients with diabetes and hypertension had a significantly longer duration of hypertension than patients with hypertension only, with an average difference of 3.2 years (95% CI: 1.56 to 4.84; p<0.001). Additionally, there was a higher level of HbA1c in diabetic hypertensive patients compared to other participants, with an average difference of 2.3% (95% CI: 1.96 to 2.64; p<0.001). The described characteristics suggest that duration of hypertension can be used as a potential confounding factor in intergroup comparisons.

Echocardiography revealed an increased myocardial wall thickness and the larger value of the indexed left ventricular mass in the group with diabetes and hypertension. Interventricular septal thickness was larger in diabetic hypertensive patients by 1.7 mm (95% CI: 1.17 to 2.23; p<0.001), while the posterior wall thickness was larger in diabetic hypertensive patients by 1.4 mm (95% CI: 0.91 to 1.89; p<0.001). Moreover, the indexed left ventricular mass was larger in diabetic hypertensive patients by 22.3 g/m^2 (95% CI: 13.88 to 30.72; p<0.001). There was a large standardized difference between the groups. Lastly, relative wall thickness in diabetic hypertensive patients was larger by 0.06 (95% CI: 0.037 to 0.083; p<0.001). The only lower parameter of echocardiography in the group with diabetes and hypertension was the L

Table 3. Distribution of Left Ventricular Geometric Patterns by Diabetic Status

Left Ventricular Geometric Pattern	Diabetic Hypertensive (n=47), n (%)	Non-Diabetic Hypertensive (n=47), n (%)	Total Sample (N=94), n (%)
Normal geometry	2 (4.3)	6 (12.8)	8 (8.5)
Concentric remodeling	5 (10.6)	12 (25.5)	17 (18.1)
Eccentric hypertrophy	13 (27.7)	21 (44.7)	34 (36.2)
Concentric hypertrophy	27 (57.4)	8 (17.0)	35 (37.2)

Chi-square test for overall distribution: χ^2=13.064; p=0.004. Cramer's V=0.37. The test compares the full distribution of left ventricular geometric categories across diabetic status.

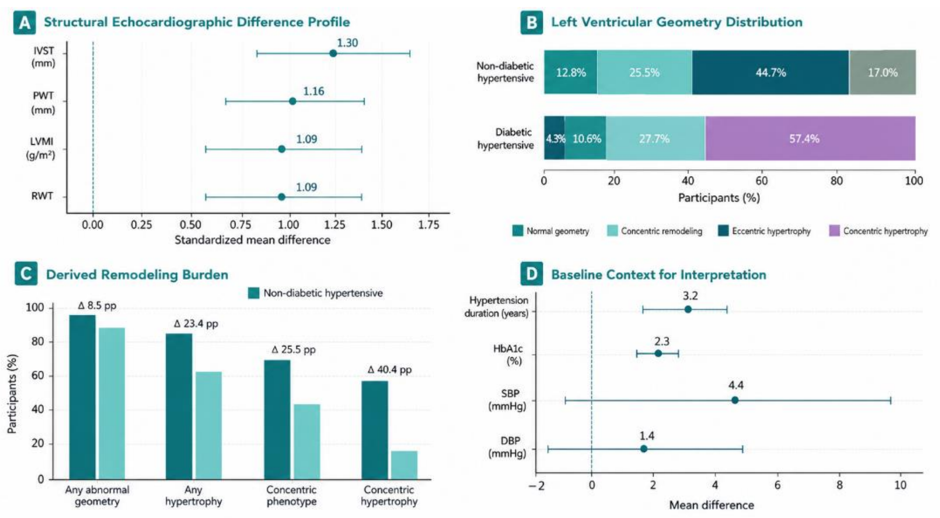

Figure 1 presents the left ventricular remodeling phenotype among diabetic and non-diabetic hypertensive patients receiving maintenance hemodialysis. Panel A shows standardized mean differences for key echocardiographic structural parameters, demonstrating larger differences for interventricular septal thickness, posterior wall thickness, left ventricular mass index, and relative wall thickness in diabetic hypertensive patients. Panel B shows the distribution of left ventricular geometry, with concentric hypertrophy occurring in 57.4% of diabetic hypertensive patients compared with 17.0% of non-diabetic hypertensive patients, whereas eccentric hypertrophy was more frequent in the non-diabetic group. Panel C summarizes derived remodeling burden, showing higher frequencies of any hypertrophy, concentric phenotype, and concentric hypertrophy among diabetic hypertensive patients. Panel D contextualizes interpretation by showing baseline mean differences, including longer hypertension duration and higher HbA1c in the diabetic hypertensive group.

Left ventricular geometry distribution varied for hypertensive diabetic hemodialysis patients and hypertensive non-diabetic hemodialysis patients. Left ventricular concentric hypertrophy was the commonest left ventricular geometric pattern for hypertensive diabetic patients, who had it in 27 out of 47 subjects (57.4%), while 8 out of 47 subjects (17.0%) of the hypertensive non-diabetic group had it. On the other hand, eccentric hypertrophy was commoner in hypertensive non-diabetic patients, since they had it in 21 out of 47 subjects (44.7%), while 13 out of 47 subjects (27.7%) of hypertensive diabetic patients had it. The total distribution of left ventricular geometry was significantly different according to diabetic status (χ^2=13.064; p=0.004) with a moderate

Table 4. Clinically Relevant Remodeling Burden by Study Group

Remodeling Category	Diabetic Hypertensive (n=47), n (%)	Non-Diabetic Hypertensive (n=47), n (%)	Total Sample (N=94), n (%)
Any abnormal geometry	45 (95.7)	41 (87.2)	86 (91.5)
Any hypertrophy	40 (85.1)	29 (61.7)	69 (73.4)
Concentric phenotype	32 (68.1)	20 (42.6)	52 (55.3)
Eccentric hypertrophy	13 (27.7)	21 (44.7)	34 (36.2)
Concentric hypertrophy	27 (57.4)	8 (17.0)	35 (37.2)

The derived remodeling classes indicated that there was increased structural load among the diabetic hypertensive patients. Abnormal left ventricular geometry was present in 45 out of 47 (95.7%) diabetic hypertensive patients and 41 out of 47 (87.2%) non-diabetic hypertensive patients. Hypertrophy was present in 40 diabetic hypertensive patients (85.1%) as compared to 29 non-diabetic hypertensive patients (61.7%). The concentric remodeling class, which included both concentric remodeling and hypertrophy, was present in 32 diabetic hypertensive patients (68.1%) compared to 20 non-diabetic hypertensive patients (42.6%). Derived classes are consistent with increased LVMI and RWT noted in the diabetic hypertensive population.

Diabetic hypertensive patients on maintenance hemodialysis had increased left ventricular mass index, increased relative wall thickness, increased thickness of septum and posterior wall, and increased concentration of concentric hypertrophy compared with non-diabetic hypertensive patients. The findings indicate the relationship between diabetes and a more concentric pattern of left ventricular remodeling in hypertensive hemodialysis patients; however, due to the cross-sectional study design and different baseline hypertension duration in the two populations, the findings should be interpreted as comparative associations.

DISCUSSION

From the results of the current study, it can be concluded that the patients suffering from diabetic hypertension under maintenance hemodialysis treatment exhibited a more unfavorable left ventricular structural pattern compared to patients with hypertension who do not suffer from diabetes, which was reflected in the higher values of left ventricular mass index, relative wall thickness, interventricular septum thickness, posterior wall thickness, and in a more frequent occurrence of concentric hypertrophy. Even though both of the above groups of patients are under the impact of three factors that pose a risk to their cardiovascular health, namely end-stage renal disease, hypertension, and maintenance hemodialysis, there was revealed a specific pattern of the left ventricular remodeling in the case of the first group, which manifested itself in the prevalence of concentric hypertrophy. The importance of the results of this research for clinical practice lies in the fact that left ventricular geometry contains much more prognostic data than only left ventricular hypertrophy does, and concentric hypertrophy usually is accompanied by impaired diastolic function, myocardial stiffness, arrhythmogenic susceptibility, and elevated cardiovascular risk (10).

The elevated level of the left ventricular mass index among the diabetic hypertensive group of patients can be explained by the assumption that diabetes promotes the process of myocardial structural remodeling through mechanisms other than just raising of the blood pressure. Hyperglycemia, advanced glycation end products formation, endothelial dysfunction, oxidative stress, myocardial ischemia, altered myocardial metabolism, and myocardial fibrosis may cause the increase of myocardial stiffness and wall thickening in patients with diabetes (11). However, due to the cross-sectional design of the current study, it cannot be claimed that the differences found between the groups reflect the causative link between diabetes and left ventricular remodeling.

The frequency of different types of left ventricular geometry provides additional evidence for the presence of phenotypic differences between the groups. Concentric hypertrophy was found in 57.4% of diabetic hypertensive individuals compared to 17.0% of non-diabetic hypertensive participants, while eccentric hypertrophy was more common in the latter group. This finding is physiologically logical. Hemodialysis patients with eccentric hypertrophy are commonly diagnosed with chronic volume overload, anemia, arteriovenous access high-output state, and chamber dilatation, and concentric hypertrophy is related to pressure overload, arterial stiffness, and increased myocardial wall stress (12). Thus, the prevalence of concentric geometry in the studied population could be due to the combination of myocardial injury in diabetes, longer exposure to hypertension, and uremic cardiac remodeling. It should be noted that the average duration of hypertension in the diabetic group was significantly longer, which should be considered a possible confounding factor when interpreting the results.

The study is clinically important since it provides grounds for individual cardiovascular surveillance of patients in hemodialysis units. Indeed, hemodialysis patients are usually considered a high-risk group, but the current study shows that the diagnosis of diabetes can be used as a tool for selecting the subgroup characterized by higher incidence of concentric cardiac remodeling phenotype. Therefore, it is possible that patients with diabetes and hypertension should undergo more intensive monitoring, including more personalized evaluation of cardiovascular risk factors. Among such risk factors, there could be optimization of blood pressure, reassessment of the dry weight, restriction of the interdialytic weight gain, treatment of anemia, blood glucose levels, and diastolic dysfunction (13). However, these considerations should be viewed critically since the current study did not prove the benefits of phenotype-oriented approach.

This aspect of relevance of these results at the local level is equally worthy of attention. In Pakistan, diabetes mellitus, hypertension, and chronic kidney disease patients can suffer from delayed diagnosis, unbalanced maintenance of cardiometabolic parameters over time, and absence of echocardiography screening before starting dialysis sessions (14). All of this can lead to severe cardiac remodeling prior to entry into hemodialysis program. Thus, this research contributes contextual information about cardiac remodeling among the population of Peshawar and underlines the need for localization of cardiovascular risk profile among dialysis patients. At the same time, generalization to other geographic locations should be carried out cautiously due to different characteristics of the dialysis process, socio-economic situation, comorbid burden, medications availability, and referral systems in urban and rural areas.

One of the strengths of this study is consistent timing of echocardiographic examinations that was conducted within 12 to 24 hours after mid-week dialysis session. This is important since left ventricular size and mass measurements depend on the intravascular volume state among dialysis patients. Moreover, using a single blinded cardiologist helped in reducing inter-observer variance of echocardiographic measurements. Finally, exclusion of patients with valvular heart disease, congenital cardiac disorders, myocardial infarction, and poor echocardiographic windows from the study helped in minimizing the impact of significant structural confounding variables independent of left ventricular geometric pattern (15).

Some limitations should be mentioned. Firstly, the cross-sectional design is not adequate for studying temporal changes in the structure of the left ventricle and drawing conclusions about causation. Secondly, the sample size was relatively small, and consecutive sampling without probability was used. Thirdly, even though the groups did not differ significantly in terms of the studied covariates, the patients with diabetes and hypertension had a longer duration of hypertension and HbA1c, while adjusted multiple regressions are not provided. Moreover, antihypertensive medications, adequacy of dialysis, degree of anemia, parameters of mineral bone diseases, weight increase between sessions, arteriovenous fistula, inflammation, and volume status might be the possible confounding factors affecting left ventricular remodeling. Fourthly, echocardiographic examinations were conducted by one cardiologist, thus providing high intra-rater consistency but no information regarding inter-observer reliability. Fifthly, conventional echocardiography with traditional structural measurements was employed in the research, but there were no speckle-tracking strain imaging, cardiac magnetic resonance imaging, or biomarkers for evaluating subclinical fibrosis and dysfunction of the myocardium (16).

Further research should involve prospective longitudinal designs for investigating how left ventricular remodeling evolves since the start of dialysis and whether being a diabetic patient contributes to the development of progression from normal morphology or concentric remodeling to hypertrophy. Multicenter studies conducted in various parts of Pakistan will be beneficial in terms of enhancing the generalizability of the results and accounting for confounders related to clinical, biochemical, dialysis, and treatment aspects. The future research should involve multivariable regression analysis, estimation of the effects with 95% confidence intervals and outcomes of hospitalization due to heart failure, arrhythmias, cardiovascular and overall death. Advanced echocardiographic methods such as global longitudinal strain, tissue Doppler indices, and cardiac magnetic resonance imaging might provide additional information on whether the phenomenon of concentric remodeling in the group of diabetic hypertensive hemodialysis patients indicates more significant myocardial fibrosis, impairment of the relaxation process or subclinical systolic dysfunction (17,18).

CONCLUSION

Left ventricular remodelling was more adverse in diabetic hypertensive patients on maintenance hemodialysis compared to non-diabetic hypertensive patients because diabetic hypertensive patients on maintenance hemodialysis had higher left ventricular mass index, larger relative wall thickness, thicker septal and posterior walls, and were more likely to have concentric hypertrophy. Diabetic hypertensive patients undergoing maintenance hemodialysis appear to have a more concentric left ventricular remodelling profile when compared to their non-diabetic counterparts despite the fact that this study adopted a cross-sectional design and the duration of hypertension in the diabetic hypertensive group was longer.

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