Echocardiographic Changes in Patients with End-Stage Renal Disease at Initiation of Dialysis

Shabana Nazneen, Muzamil Latief, Manjusha Yadla

Department of Nephrology, Gandhi Medical College, Secunderabad, Hyderabad, India

Abstract

Introduction: Echocardiography is a simple and established method of evaluating cardiac functions, assessing left ventricle geometry, and systolic and diastolic functions. Patients with chronic kidney disease have a tremendous burden of cardiovascular disease (CVD), and patients with end-stage renal disease (ESRD) are at a greater risk of CVD and deaths.

Materials and Methods: In this study, 245 incident dialysis patients were included, and none of the patient was on erythropoietin. All the patients were aged >18 years. Patients with ESRD, already on maintenance dialysis, were not included in this study. Patient’s data such as demographic details, comorbidities, laboratory values, echocardiographic changes, management, and outcome were recorded.

Results: Out of 245 patients, 165 (67.3%) were males and 80 (32.6%) females. The mean age of the patients was 49.7 years. Left ventricular hypertrophy (LVH) was observed in 188 (76.7%), mild left ventricular dysfunction (LVD) in 25.7%, moderate LVD in 23.67%, severe LVD in 8.5%, global hypokinesia in 33.8%, valvular heart disease in 26.5%, regional wall motion abnormality in 4.4%, and pericardial effusion in 1.6% patients. Echocardiographic changes, such as LVD, LVH, and global hypokinesia, were observed in greater number in hypertensive group compared to normotensive group (P < 0.05). On regression analysis adjusted for age and gender, we found that hypertension and anemia (<10 g/dL) were associated with LVH. Further, hypertension and anemia (Hb < 10 g/dL) were associated with LVD. Similarly, anemia (Hb < 10 g/dL) was associated with global hypokinesia and valvular heart disease. LVD was associated with death in our study.

Conclusion: Echocardiography is a noninvasive diagnostic test which detects early changes in cardiac parameters. All ESRD patients with hypertension and anemia at the time of initiation of renal replacement therapy must undergo echocardiography screening.

Keywords: echocardiography; hypertension; CKD

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Author for correspondence: Latief M, Department of Nephrology, Gandhi Medical College, Secunderabad, Hyderabad, India, Email: muzamillatief.b@gmail.com

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are most consistently associated with cardiac failure, a pre-lethal occurrence that leads to two-thirds of deaths in all patients on dialysis (5). The risk of cardiovascular mortality is 10- to 20-fold higher than in age- and gender-matched control subjects (2,5). One of the major structural cardiac abnormalities in patients with CKD is left ventricular hypertrophy (LVH), which is associated with increased risk for cardiac ischemia, congestive heart failure as well as a very strong independent predictor of cardiovascular mortality (1,6,7). LVH is the most common geometric abnormality in CKD and independent prognostic predictor, especially in patients on dialysis (8). Left ventricular dysfunction (LVD) on start of hemodialysis is a stratifying risk of CVD and an all-cause mortality in ESRD (6,9). It is strongly associated with cardiac failure and as one of the independent predictors of cardiovascular death. Echocardiography is a simple and established method of evaluating cardiac functions, assessing left ventricle geometry, and systolic and diastolic functions.

Materials and Methods

In this prospective observational study conducted in a tertiary care teaching hospital over a period of 1 year, the included patients were incident dialysis patients, and none of the patient was on erythropoietin. All the patients were aged >18 years. Patients with ESRD already on maintenance dialysis were not included in this study. Patient data such as demographic details, comorbidities, laboratory values, echocardiographic changes, management, and outcome were recorded. Echocardiography (two-dimensional and M-mode) was done in all patients. A total of 245 patients were included in the study. Data analysis was performed using statistical software SPSS (Version 20.0). Descriptive statistics were used for the analysis. Statistical tests were two-tailed, and P < 0.05 was considered to show a statistical difference. Chi-square test for association was performed between different treatment modalities used and the patient outcomes.

Results

Out of the included 245 patients, 165 (67.3%) were males and 80 (32.6%) females. The mean age of the patients was 49.7 years, and the mean serum creatinine was 7.7 mg/dL. The majority of patients were in the age group of 41–50 years, as shown in Table 1. Hypertension was found in 199 (81%), diabetes in 70 (28.5%), coronary heart disease (CHD) in 18 (7.3%), and anemia in 193 (78.7%) patients. Etiology of the CKD was presumed. Chronic interstitial nephritis (CIN) was established in 189 (77.1%), chronic glomerulonephritis (CGN) in 26 (10.6%), diabetic kidney disease in 23 (9.3%), and polycystic kidney disease in 7 (2.8%) patients. LVH was observed in 188 (76.7%), mild LVD in 25.7%, moderate LVD in 23.67%, severe LVD in 8.5%, global hypokinesia in 33.8%, valvular heart disease in 26.5%, regional wall motion abnormality (RWMA) in 4.4%, and pericardial effusion in 1.6% patients (Table 2). Echocardiographic changes, such as LVD, left ventricular hypertrophy (LVH), and global hypokinesia, were found in greater number in hypertensive group compared to normotensive group (P < 0.05) (Table 3). Patients with hemoglobin (Hb) < 10 gm/dL had echocardiographic changes such as LVH in 82%, LVD in 66%, global hypokinesia in 49%, and valvular heart disease in 30% patients, with statistically significant P < 0.05, compared with anemic patients with Hb >10 gm/dL (Table 4). Patients were further analyzed on the basis of ejection fraction (EF), and demographic details, comorbidities, and echocardiographic changes and outcomes were also studied. In reduced EF group, 68.7% were females, 64% had hypertension, 75.8% had LVH, and RWMA was found in 81.8% patients. Among patients who died, 92.3% had reduced EF (Table 5). Patients with LVD and global hypokinesia had higher mortality compared with those who had normal left ventricular function with a statistically significant P < 0.05 (Table 6). On regression analysis adjusted for age and gender, we found that hypertension and anemia (Hb < 10 g/dL) was associated with

| Table 1: Demographic details of patients |
|-----------------------------------------|
| Mean age                               | 49.7 |
| Mean serum creatinine                   | 7.7  |
| Males                                  | 165 (67%) |
| Females                                | 80   |

| Table 2: Echocardiographic changes. |
|-------------------------------------|
| Echocardiographic Changes           | Number of Patients |
|-------------------------------------|--------------------|
| LVH                                 | 188 (76.7%)        |
| Mild LVD                            | 63 (25.7%)         |
| Moderate LVD                        | 58 (23.67%)        |
| Severe LVD                          | 21 (8.5%)          |
| Global hypokinesia                  | 83 (33.8%)         |
| RWMA                                | 11 (4.4%)          |
| Valvular heart disease              | 65 (26.5%)         |
| Pericardial effusion                | 4 (1.6%)           |

RWMA: regional wall motion abnormalities; LVD: left ventricular dysfunction; LVH: left ventricular hypertrophy.
Table 3: Echocardiographic changes compared in normotensive and hypertensive patients.

|                      | Hypertensive (N = 199) | Normotensive (N = 46) | P-value  |
|----------------------|------------------------|-----------------------|----------|
| LVD                  | 128                    | 14                    | 0.00032  |
| LVH                  | 174                    | 14                    | <0.001   |
| Global hypokinesia   | 74                     | 9                     | 0.02     |
| RWMA                 | 10                     | 1                     | 0.47     |
| Valvular heart disease | 59                   | 6                     | 0.025    |
| Pericardial effusion | 2                      | 2                     | 0.16     |

RWMA: regional wall motion abnormalities; LVD: left ventricular dysfunction; LVH: left ventricular hypertrophy.

Table 4: Echo changes compared with hemoglobin values.

|                      | Hb < 10 gm/dL (N = 193) | Hb > 10 gm/dL (N = 52) | P-value  |
|----------------------|-------------------------|------------------------|----------|
| LVH                  | 159 (82%)               | 29 (15%)               | 0.0003   |
| LVD                  | 128 (66%)               | 14 (7.2%)              | <0.0001  |
| Global hypokinesia   | 79 (49%)                | 4 (2%)                 | 0.000004 |
| RWMA                 | 10 (5.1%)               | 1 (0.5%)               | 0.47     |
| Valvular heart disease | 58 (30%)             | 7 (3.6%)               | 0.02     |
| Pericardial effusion | 3 (1.5%)                | 1 (0.5%)               | 1        |

RWMA: regional wall motion abnormalities; LVD: left ventricular dysfunction; LVH: left ventricular hypertrophy.

Table 5: Comparison of groups with preserved and reduced ejection fraction

| Column 1 | Preserved EF (103) | Reduced EF (n = 142) | P value |
|----------|-------------------|----------------------|---------|
| Male     | 76 (46.6%)        | 87 (53.7%)           |         |
| Female   | 26 (32.5%)        | 55 (68.7%)           |         |
| HTN      | 71 (35.6%)        | 128 (64%)            | 0.00003 |
| DM       | 29 (41.4%)        | 41 (56.9%)           | 1       |
| CAD      | 3 (16.6%)         | 15 (83%)             | 0.02    |
| LVH      | 43 (24%)          | 135 (75.8%)          | 2.6     |
| RWMA     | 2 (18%)           | 9 (81.8%)            | 0.1     |
| Valvular heart disease | 14 (22.9%)     | 47 (77%)             | 0.00052 |
| PE       | 2 (40%)           | 3 (60%)              | 1       |
| Global hypokinesia | 13 (13.5%)    | 83 (86.4%)           | 2.3     |
| Hb < 10 gm/dL | 65 (33.6%)     | 128 (66.3%)          | 3.7     |
| Death    | 2 (7.6%)          | 24 (92.3%)           | 0.00021 |

HTN: Hypertension; DM : Diabetes Mellitus; CAD: Coronary artery disease; LVH: Left Ventricular Hypertrophy; PE: Pericardial Effusion; Hb: Haemoglobin
LVH with odds ratio (OR) = 0.06 and 0.29 (P < 0.001 and P = 0.003), respectively. Further, hypertension and anemia (Hb < 10 g/dL) were associated with LVD with OR = 3.36 and 5.04 (P = 0.001 and P < 0.001), respectively. Similarly, anemia (Hb < 10 g/dL) was associated with global hypokinesia, OR = 8.44 (P < 0.001) and valvular heart disease, OR = 4.02 (P = 0.006). LVD was associated with mortality with OR = 16.9 (P = 0.001).

Discussion
Cardiovascular disease is very common in patients with CKD, and is by far the leading cause of morbidity and mortality in end-stage renal disease. We observed that majority of the patients were aged 41–50 years, with the mean age of 49.7 years, similar to the findings of Singh et al. (5) (Table 7). In our study, male population (67%) was predominant, similar to Singh et al. (5) and Foley et al. (7). Hypertension was found in 81.2% patients, correlating with other studies (6,8). We observed significant echocardiographic changes in hypertensive group compared to normotensive group. LVH was examined in 76% patients, as observed by Laddha et al., who observed LVH in 74% patients in their study (10). In a study conducted by Zoccali et al., LVH was found in 77% patients (9). Similar observations were made by Singh et al. (5). In anemic patients (with Hb < 10 gm/dL), echocardiographic changes were observed correlating with other studies. In anemic patients, LVH was found in 82% and LVD in 66% cases. It was comparable with the observations made by Singh et al. (5), Parfrey et al. (8), and Datta et al. (11). Patients with reduced EF had higher risk of valvular heart disease and significant mortality, similar to the observations made by Yamada et al. (6). Mortality occurred in 26 (10.6%) patients; among these, Hb < 10 gm/dL was found in 23 (88.4%), LVH in 23 (88.4%), LVD in 24 (92%), and global hypokinesia in 19 (73%) patients, correlating with the studies carried out by Yamada et al. (6) and Zoccali et al. (9).

Table 6: Factors associated with mortality.

|                | Death (N = 26) | Alive | P-value |
|----------------|---------------|-------|---------|
| Hb < 10 gm/dL  | 23            | 0.3   |         |
| LVH            | 23            | 0.2   |         |
| LVD            | 24            | 0.002 |         |
| Global hypokinesia | 19       | 0.0001|         |
| RWMA           | 3             | 0.1   |         |
| Valvular heart disease | 9       | 0.3   |         |
| Pericardial effusion | 1       | 0.3   |         |

RWMA: regional wall motion abnormalities; LVD: left ventricular dysfunction; LVH: left ventricular hypertrophy.

Table 7: Comparison with other studies.

|                  | N     | LVH    | LVD             | Hb (<10 gm/dL) |
|------------------|-------|--------|-----------------|---------------|
|                  | Overall | HTN |           |               |
| Present study    | 245    | 76.7% | 87%         | 82%           | 57%           |
| Foley et al. (7) | 433    | 75%   |               |               |
| Bansal et al. (1)| 190    | 79%   |               |               |
| Laddha et al. (10)| 70   | 74%   | 74%           | 82%           | 23%           |
| Zoccali et al. (9)| 71%   |       |               |               |
| Yamada et al. (6)| 1254   | 13%   | EF < 35 predicts poor outcome |
| Datta et al. (11)| 230    | 96%   |               |               |

LVD: left ventricular dysfunction; LVH: left ventricular hypertrophy; EF: ejection fraction; HTN: Hypertension

Limitations
This was a 1-year study and no further follow-up took place.

Conclusion
Echocardiography is a noninvasive diagnostic test to detect early changes in cardiac parameters. All ESRD patients with hypertension and anemia at the time of initiation of renal replacement therapy (RRT) should undergo echocardiography screening.
Conflict of Interest

None. All the authors contributed equally to this study.

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