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Original Research Article

Association of Cardiac Valve Calcification with Cardiovascular Complications and Mortality in Hemodialysis Patients: A Retrospective Cohort Study

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Conflict of interest: Nil

Abstract:

Background: Cardiovascular disease is the most common cause of morbidity and mortality in end stage renal disease (ESRD) patients on maintenance hemodialysis (MHD). The accumulation of calcium in the cardiac valves (CVC) is a growing trend to acknowledge this population as a marker of systemic cardiovascular risk, especially for the aortic and mitral valves.

Objectives: This study sought to assess the relationship between cardiac valve calcification and cardiovascular complications and mortality in maintenance hemodialysis (MHD) patients.

The methodology used: A retrospective study of the Department of General Medicine, Netaji Subhas Medical College & Hospital, Patna, Bihar, was carried out. A total of 130 adult patients with ESRD who were on maintenance hemodialysis were enrolled and divided into two groups: CVC patients, those with a positive CVC; and CVC negative, those with a negative CVC. Data on demographics, clinical, laboratory, echocardiographic, cardiovascular outcome and mortality data were analysed.

Results: Fifty-eight patients (44.6%) had cardiac valve calcification. Significant differences were observed between patients with CVC and those with non-CVC in age, diabetes mellitus, previous history of cardiovascular disease, left atrial enlargement, interventricular septal thickness, left ventricular mass index, serum albumin, and β2-microglobulin. The CVC group had significantly higher all-cause mortality (41.4% vs 19.4%), cardiovascular mortality (31.0% vs 11.1%), major cardiovascular events, hospitalization for heart failure, acute coronary syndrome and stroke. CVC was an independent predictor of all-cause and cardiovascular mortality, as was revealed by multivariate Cox regression analysis.

Conclusion: There is strong association of cardiac valve calcification with poor cardiovascular outcomes and death in maintenance hemodialysis patients. Echocardiographic screening can be useful in identifying high-risk individuals and in providing the opportunity for early preventive measures.

Keywords: Cardiac valve calcification; Hemodialysis; Cardiovascular mortality; End-stage renal disease; Echocardiography; Cardiovascular complications.

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Introduction

End-stage renal disease (ESRD) is the final stage of chronic kidney disease (CKD) and a significant public health problem across the globe. Patients with ESRD must receive renal replacement therapy (RRT) to sustain their lives, either by hemodialysis, peritoneal dialysis, or kidney transplant. Even with the many advances in dialysis technique and patient care, the morbidity and mortality rates are still high in such patients. Cardiovascular disease (CVD) is known to be the leading cause of hospitalization and mortality among people on maintenance hemodialysis (MHD). Cardiovascular problems are a big problem in the care of ESRD patients and are exacerbated by the presence of chronic kidney dysfunction, which creates a mix of traditional and non-traditional cardiovascular risk factors [1].

Dialysis patients have a significantly higher burden of cardiovascular disease than the general population. Research has shown that the risk of cardiovascular mortality in patients with hemodialysis or peritoneal dialysis is about 10-20 times higher than those without kidney disease [2]. A combination of hypertension, diabetes mellitus, dyslipidemia, anemia and chronic inflammation, oxidative stress, en-

dothelial dysfunction, and abnormalities of mineral and bone metabolism are responsible for this increased risk. These factors lead to the worsening of cardiovascular function, cardiac remodeling, vascular calcification, and accelerated atherosclerosis. As a result, cardiovascular events, including ischemic heart disease, congestive heart failure, arrhythmias, cerebrovascular accidents and sudden cardiac death, are common in long-term dialysis patients.

Cardiac valve calcification (CVC) has become an important predictor of poor cardiovascular outcomes among the different cardiovascular abnormalities seen in ESRD. The pathological deposition of calcium-phosphate complexes in the valvular structures of the heart, mostly in aortic and mitral valves, is called cardiac valve calcification. Systematic calcific disease is commonly seen in patients receiving dialysis and aortic valve calcification (AVC) and mitral valve calcification (MVC) are common forms of this disease. The incidence of CVC in patients with incident hemodialysis has been reported to be as high as 57.5%, suggesting that valvular calcification is a frequent cardiovascular complication in hemodialysis patients [3]. The high incidence of CVC in ESRD patients is thought to be primarily due to disorders of calcium-phosphorus metabolism, secondary hyperparathyroidism, vitamin D deficiencies, and the effects of uremic toxins.

Pathophysiology of valvular calcification in ESRD is complex and multifactorial. In chronic inflammation, the oxidative stress and metabolic abnormalities contribute to the osteogenic transformation of the valvular interstitial cells and thus to the progressive calcification of cardiac valves. Dialysis patients develop the calcification of valves at an earlier age, and it progresses faster compared to valve calcification in the general population in the later years of life. As calcifications progress, they can lead to cardiovascular complications, such as valvular stenosis and regurgitation, left ventricular hypertrophy, and poor cardiac performance, and increase the risk of cardiovascular-related death.

There are recent indications that the cardiac valve calcification is not just a disorder of the heart valves but also reflects systemic vascular calcification and cardiovascular disease. AVC or MVC has been linked to greater arterial stiffness, coronary artery calcification, left-ventricular dysfunction and cardiovascular risk. Thus, the extent of valvular calcification could be useful for prognosis of subsequent cardiovascular events and survival in patients undergoing maintenance HD.

Associations between cardiac valve calcification and clinical outcomes in ESRD patients have been investigated in several studies. It has been previously reported that dialysis patients with mitral valve calcification and/or aortic valve calcification have significantly higher cardiovascular mortality rate and cardiovascular death rate than those without these conditions [4]. Patients with CVC tend to have more cardiovascular comorbidities, and have worse long-term outcomes compared to patients without valvular calcification. Additionally, echocardiographic detection of valvular calcification is a simple, non-invasive and inexpensive tool to help identify high-risk patients who might benefit from closer follow-up and targeted treatment.

Though association of cardiac valve calcification with mortality has been well studied in developed countries, this data is not available in the Indian population. The prevalence and prognostic role of valvular calcification in ESRD population in India could be affected by the demographic characteristics, socioeconomic status, nutritional factors, access to health care, and dialysis practice. Hence, it is necessary to conduct region-specific study to gain insight into the burden of CVC and its implications in the Indian healthcare scenario.

The present retrospective cohort study was carried out in the Department of General Medicine, Netaji Subhas Medical College and Hospital, Amhara, Bihta, Patna, Bihar, India in this context. The purpose of this study was to assess the relation between cardiac valve calcification and cardiovascular complications and mortality in patients on maintenance hemodialysis. The study also aimed to explore correlation of cardiac parameters, biochemical parameters and clinical parameters with valvular calcification for the identification of parameters associated with poor cardiac outcomes and deaths. This study's results could help with risk stratification and help to develop preventative and therapeutic approaches to decrease cardiovascular morbidity and mortality in hemodialysis patients.

Methodology

Study Design: The present study was designed as a retrospective cohort study to investigate the relationship between cardiac valve calcification (CVC) and cardiovascular complications and mortality in patients with maintenance hemodialysis (MHD).

Study Area: The study was conducted in the Department of General Medicine, Netaji Subhas Medical College and Hospital, Amhara, Bihta, Patna, Bihar, India for one year from March 2025 to February 2026

Sample Size: There were a total of 130 patients undergoing maintenance hemodialysis (MHD).

Study Population: The study population included the adult ESRD patients undergoing maintenance hemodialysis at Netaji Subhas Medical College and Hospital. The patients were divided into two groups: those with or without cardiac valve calcification using echocardiograms. Incidence of cardiovascular complication and mortality was evaluated and compared in the groups.

Data Collection: Medical records, dialysis unit records, laboratory records, echocardiographic reports, and follow-up records were used to collect data. Data gathered included demographic data (age, sex), duration of dialysis, underlying kidney disease, comorbidities, smoking status, body mass index (BMI) and drug history (phosphate binders, vitamin D).

Hb, serum calcium, serum phosphate, serum albumin, uric acid, intact parathyroid hormone (iPTH) and 25 hydroxy vitamin D level were recorded in the laboratory. Laboratory data were used that were obtained within 3 months of the echocardiographic examination.

Follow-up information and clinical outcome data for cardiovascular complications and mortality were derived from hospital records and follow-up documentation. Cardiovascular complications were ischemic heart disease, congestive heart failure, arrhythmias, cerebrovascular accidents and other documented cardiovascular complications.

Inclusion Criteria

- Patients aged ≥18 years.
- ESRD + maintenance hemodialysis for 6 months or longer.
- Patients who were undergoing regular hemodialysis at the study center.
- Complete clinical, laboratory, echocardiographic and follow up records available.
- The patients who were evaluated with transthoracic echocardiogram (TTE) during the study period.

Exclusion Criteria

- Patients with a renal transplant.
- The proportion of patients changed from hemodialysis to peritoneal dialysis (PD) during the study period.
- Congenital valvular heart disease or primary dilated cardiomyopathy patients.
- Incomplete medical records and/or missing echocardiographic data.
- Acute kidney injury (AKI) requires temporary dialysis.

Study Procedure: Patients who met the criteria for maintenance HD were selected from the dialysis unit records. The data obtained from the medical records included demographic, clinical, laboratory, and treatment-related information. The echocardiographic examinations of experienced cardiologists were reviewed.

Two dimensional and Doppler echocardiograms were used to assess cardiac valve calcification. Valve calcification was detected if one or more cusps of the aortic valve, mitral valve or mitral annulus showed bright echogenic areas of more than 1 mm. Where available, other echocardiographic parameters were recorded; these include LV end-diastolic diameter (LVEDD), left atrial dimension (LAD), interventricular septal thickness (IVST), posterior wall thickness (PWT), and left ventricular mass index (LVMI).

They were divided into CVC positive and negative groups. The two groups were compared in terms of the prevalence of cardiovascular complications and mortality outcomes. All-cause mortality and cardiovascular mortality was used for classification of mortality. Cardiovascular deaths were defined as those due to myocardial infarction, heart failure, arrhythmias, stroke, sudden cardiac death, or other cardiovascular disease.

Statistical Analysis: The data was entered into microcomputer software program Microsoft Excel and analyzed with Statistical Package for the Social Sciences (SPSS) version 22.0 (IBM Corp., USA). Means with standard deviations (SD) were used for continuous variables, and the categorical variables were presented as frequencies and percentages.

The student's t-test for normally distributed continuous variables and the Mann–Whitney U test for non-normally distributed variables were used to compare the patients in the two groups (with and without cardiac valve calcification). The Chi-square test or Fisher's exact test (FET) was used to compare categorical variables.

The difference in survival between groups was assessed using Kaplan–Meier survival analysis and the log-rank test was used to compare survival curves. Cox proportional hazards regression was used to determine the predictors for cardiovascular complications and mortality. Univariate analysis of these variables was performed to ascertain whether they were associated with the outcome with a $p<0.05$, which were subsequently included in a multivariate Cox regression model to determine independent factors. The two-sided p value < 0.05 was used as the criterion for statistical significance".

Result

The demographic, clinical, echocardiographic and laboratory data of the 130 maintenance HD patients who participated in the study are shown in Table 1. Of these, 44.6% (58 patients) had cardiac valve calcification (CVC group) and 55.4% (72 patients) did not have cardiac valve calcification (non-CVC group). Patients in the CVC group were significantly older than those in the non-CVC group (58.7 ± 11.3 vs. 50.8 ± 12.4 years, $p<0.001$). Patients with CVC had significantly higher prevalence of diabetes mellitus (34.5% vs. 16.7%, $p=0.020$) and higher proportion of cardiovascular disease (58.6% vs. 36.1%, $p=0.011$). Echocardiographic assessment revealed significantly higher left atrial diameter (3.71 ± 0.51 vs. 3.42 ± 0.47 cm, $p=0.001$), interventricular septal thickness (1.24 ± 0.15 vs. 1.17 ± 0.12 cm, $p=0.003$),

and left ventricular mass index (130.5 ± 35.6 vs. 118.4 ± 30.2 g/m², p=0.041) in the CVC group. Serum albumin levels were found to be lower and β2-microglobulin levels higher in patients with valve calcification than in those without (38.9 ± 3.4 mg/L vs. 40.6 ± 3.2 mg/L; p=0.005 and 31.1 ± 7.0 mg/L vs. 28.7 ± 6.2 mg/L; p=0.041, respectively). The distribution of sex, smoking, hemodialysis duration, BMI, calcium, phosphorus, hemoglobin, uric acid, iPTH or vitamin D levels did not differ significantly between the two groups.

Table 1: Baseline Clinical and Laboratory Characteristics in the Non-CVC and CVC Groups (N=130)

Variable	Non-CVC (n = 72)	CVC (n = 58)	P value
Age (years)	50.8 ± 12.4	58.7 ± 11.3	<0.001
Duration of HD (years)	3.1 ± 2.8	3.8 ± 3.0	0.184
Men, n (%)	45 (62.5)	35 (60.3)	0.801
Smoking, n (%)	12 (16.7)	8 (13.8)	0.651
Hypertension, n (%)	58 (80.6)	50 (86.2)	0.398
Diabetes, n (%)	12 (16.7)	20 (34.5)	0.02
Cardiovascular disease, n (%)	26 (36.1)	34 (58.6)	0.011
Phosphate binder use, n (%)	56 (77.8)	40 (69.0)	0.254
Vitamin D therapy, n (%)	62 (86.1)	43 (74.1)	0.082
BMI (kg/m²)	23.2 ± 3.6	22.7 ± 3.5	0.432
LAD (cm)	3.42 ± 0.47	3.71 ± 0.51	0.001
LVDd (cm)	4.70 ± 0.58	4.82 ± 0.66	0.278
IVST (cm)	1.17 ± 0.12	1.24 ± 0.15	0.003
LVPWT (cm)	1.12 ± 0.11	1.16 ± 0.12	0.067
LVMI (g/m²)	118.4 ± 30.2	130.5 ± 35.6	0.041
EF (%)	61.8 ± 7.2	60.5 ± 8.8	0.352
Hemoglobin (g/L)	106.2 ± 14.8	101.8 ± 15.3	0.098
Calcium (mmol/L)	2.21 ± 0.21	2.25 ± 0.24	0.317
Phosphorus (mmol/L)	2.04 ± 0.57	2.11 ± 0.60	0.486
β2-Microglobulin (mg/L)	28.7 ± 6.2	31.1 ± 7.0	0.041
iPTH (pg/mL)	376.5 ± 298.4	351.8 ± 315.7	0.641
Albumin (g/L)	40.6 ± 3.2	38.9 ± 3.4	0.005
Uric Acid (μmol/L)	468.3 ± 91.6	455.4 ± 88.7	0.421
25(OH)D (ng/mL)	20.4 ± 8.8	18.9 ± 8.2	0.326

The clinical outcomes observed during the follow-up period are summarized in Table 2. If cardiac valve calcification was present, there were significantly worse outcomes than when it was not present. In the CVC group, all-cause mortality occurred in 24 patients (41.4%) while in the non-CVC group, it occurred in 14 patients (19.4%) (p=0.006). Similarly, the patients with CVC had significantly higher cardiovascular mortality compared to the non-CVC patients (31.0% vs. 11.1%, p=0.004). The CVC group had a higher rate of major cardiovascular events than the non-CVC group (44.8% vs. 22.2%, p=0.007). Heart failure was also more common when patients were hospitalized (32.8% vs 13.9%, p=0.011) in patients with valve calcification. Further, there was a significantly higher prevalence of acute coronary syndrome in the CVC group (24.1%) compared with the non-CVC group (8.3%) (p=0.015). Patients with CVC experienced a higher rate of stroke events, 17.2% vs. 5.6% (p=0.031) of patients without CVC. The results suggest that there is a strong association between the presence of cardiac valve calcification and cardiovascular complications and death in maintenance hemodialysis patients.

Table 2: Clinical Outcomes During Follow-up (N=130)

Outcome	Non-CVC (n = 72)	CVC (n = 58)	P value
All-cause mortality, n (%)	14 (19.4)	24 (41.4)	0.006
Cardiovascular mortality, n (%)	8 (11.1)	18 (31.0)	0.004
Major cardiovascular events, n (%)	16 (22.2)	26 (44.8)	0.007
Heart failure hospitalization, n (%)	10 (13.9)	19 (32.8)	0.011
Acute coronary syndrome, n (%)	6 (8.3)	14 (24.1)	0.015
Stroke, n (%)	4 (5.6)	10 (17.2)	0.031

The multivariate Cox proportional hazards regression analysis results for the factors associated with all-cause mortality are shown in Table 3. Cardiac valve calcification was an independent predictor of

all-cause mortality, with a risk of around 89% (HR: 1.89, 95% CI: 1.12–3.18; p=0.017) following adjustment for potential confounding variables. The risk of mortality was significantly increased with age (HR: 1.03; 95% CI: 1.01–1.06; p=0.003). Patients with diabetes mellitus were more than twice as likely to die as were non-diabetic patients (HR: 2.14, 95% CI: 1.23 to 3.74, p=0.007). Previous history of cardiovascular disease also was independently associated with increased mortality (HR: 1.76, 95% CI: 1.04–2.98; p=0.034). In contrast, therapy with vitamin D was protective, with a 36% decrease in risk of mortality (HR: 0.64, 95% CI: 0.39–0.97; p=0.041). A higher left atrial diameter was shown to be a significant risk factor for mortality (HR 1.48 (1.05–2.10); p=0.026). Other parameters that were identified as significant predictors of all-cause mortality were lower hemoglobin, higher β2-microglobulin, and lower serum albumin levels, which indicates that anemia, inflammatory markers, and poor nutritional status play important roles in the prediction of long-term mortality in HD patients.

Table 3: Multivariate Cox Regression Analysis for All-Cause Mortality

Variable	HR (95% CI)	P value
Cardiac valve calcification	1.89 (1.12–3.18)	0.017
Age	1.03 (1.01–1.06)	0.003
Diabetes mellitus	2.14 (1.23–3.74)	0.007
Cardiovascular disease history	1.76 (1.04–2.98)	0.034
Vitamin D therapy	0.64 (0.39–0.97)	0.041
LAD	1.48 (1.05–2.10)	0.026
Hemoglobin	0.98 (0.96–0.99)	0.012
β2-Microglobulin	1.03 (1.01–1.06)	0.021
Albumin	0.93 (0.88–0.99)	0.018

Multivariate Cox regression analysis for cardiovascular mortality was presented in table 4. Cardiac valve calcification was a significant and independent predictor of cardiovascular death with patients having a 2.56-fold increased risk for cardiovascular death than those without (HR: 2.56, 95% CI: 1.41–4.66; p=0.002). One of the most important risk factors continued to be diabetes mellitus and was found to be associated with almost a threefold increase in the cardiovascular mortality risk (HR: 2.72, 95% CI: 1.42–5.23; p=0.003). Likewise, prior history of cardiovascular diseases also significantly increased cardiovascular death (HR: 2.31, 95% CI: 1.24–4.29; p=0.008). There was a significant reduction in cardiovascular mortality with vitamin D therapy (HR: 0.58, 95% CI: 0.34–0.96; p=0.035). Cardiac structural abnormalities were also of prognostic value: increased left atrial diameter was an independent predictor of cardiovascular death (HR: 1.91, 95% CI: 1.21–3.03; p=0.005). A reduction in hemoglobin and an increase in β2-microglobulin levels were also important predictors of cardiovascular mortality. There was a trend of protection with serum albumin, but the association was not statistically significant in the multivariate model (HR: 0.96, 95% CI: 0.89–1.03; p=0.218). In summary, the results indicate that cardiac valve calcification, diabetes, pre-existing cardiovascular disease, cardiac remodeling, and clinical indicators of poor clinical status are significant factors in cardiovascular mortality of maintenance HD patients.

Table 4: Multivariate Cox Regression Analysis for Cardiovascular Mortality

Variable	HR (95% CI)	P value
Cardiac valve calcification	2.56 (1.41–4.66)	0.002
Age	1.02 (0.99–1.05)	0.096
Diabetes mellitus	2.72 (1.42–5.23)	0.003
Cardiovascular disease history	2.31 (1.24–4.29)	0.008
Vitamin D therapy	0.58 (0.34–0.96)	0.035
LAD	1.91 (1.21–3.03)	0.005
Hemoglobin	0.97 (0.95–0.99)	0.019
β2-Microglobulin	1.04 (1.01–1.08)	0.014
Albumin	0.96 (0.89–1.03)	0.218

Discussion

To assess the relation of cardiac valve calcification (CVC) with cardiovascular complications and mortality in maintenance hemodialysis (MHD) patients in a retrospective cohort study. We found that the proportion of cardiovascular risk factors was significantly higher and clinical outcomes worse in patients with CVC compared with those without CVC. Patients with CVC were significantly older (58.7 ± 11.3 vs. 50.8 ± 12.4 years, p<0.001) and had a higher prevalence of diabetes mellitus (34.5% vs. 16.7%,

p=0.02) and pre-existing cardiovascular disease (58.6% vs. 36.1%, p=0.011). The results here are in keeping with previous reports that aging, diabetes and cardiovascular comorbidities are associated with accelerated valvular and vascular calcifications in end-stage renal disease (ESRD) dialysis patients" [1,4].

Echocardiographic profile of patients with CVC also showed considerable structural cardiac abnormalities. Patients with CVC had significantly increased diameter of the left atrium (LAD), interventricular septal thickness (IVST), left ventricular mass index (LVMI) and demonstrated a more significant degree of cardiac remodeling. Specifically, LAD was significantly larger in the CVC group (3.71 ± 0.51 cm vs. 3.42 ± 0.47 cm, p=0.001), while LVMI was elevated (130.5 ± 35.6 vs. 118.4 ± 30.2 g/m², p=0.041). The same finding was described by Sha et al. [5] that LVMI is a significant predictor of death in hemodialysis patients, and by Zoccali et al. [6] that the progression of left ventricular hypertrophy was a risk factor for cardiovascular event and mortality. In our multivariate analysis, however, LVMI was not an independent predictor, even though it was higher in the CVC group, indicating the role of cardiac hypertrophy may be mediated by other clinical parameters (e.g. valvular calcification and atrial enlargement).

In follow-up, the clinical outcomes in patients with CVC were significantly worse. The mortality rate was over 2 times higher for patients with CVC than for patients without CVC (41.4% vs. 19.4%, p=0.006), and nearly 3 times as high for cardiovascular mortality (31.0% vs. 11.1%, p=0.004). Similarly, major cardiovascular events occurred more frequently in the CVC group (44.8% vs. 22.2%, p=0.007), including hospitalizations for heart failure (32.8% vs. 13.9%, p=0.011), acute coronary syndrome (24.1% vs. 8.3%, p=0.015), and stroke (17.2% vs. 5.6%, p=0.031). These results confirm that the presence of valvular calcification is not only a sign of a mineral metabolism disturbance, but of the overall cardiovascular disease pathology and more atherosclerotic burden. Results comparable to these were found by Takahashi et al. [3] who reported that the presence of cardiac valvular calcification was an independent predictor of cardiovascular mortality and all-cause mortality in incident hemodialysis patients. Moreover, Wang et al. performed a meta-analysis that confirmed that dialysis patients had a significantly greater risk of cardiovascular and overall death associated with cardiac valve calcification.

Furthermore, multivariate Cox regression analysis also confirmed the prognostic value of CVC. CVC was still an independent predictor of all-cause mortality (HR=1.89, 95% CI: 1.12–3.18, p=0.017) and cardiovascular mortality (HR=2.56, 95% CI: 1.41–4.66, p=0.002) after adjusting for potential confounders. These findings corroborate with those found by Raggi et al. [7] who found that valvular calcification was significantly associated with mortality in hemodialysis patients. Similarly, Li et al. [8] demonstrated that aortic valve calcification was an independent risk factor for cardiovascular mortality in long-term hemodialysis patients. The prognostic importance of mitral or aortic valve calcification is controversial in prior studies, but overall, the data indicate that any valvular calcification is a high-risk cardiovascular phenotype.

It was also noted in the present study that there was a strong relationship between left atrial enlargement and adverse effects. LAD was an independent predictor for all-cause mortality (HR=1.48, p=0.026) and cardiovascular mortality (HR=1.91, p=0.005). Larger left atrial dimensions have been found to be independently associated with cardiovascular events and mortality in dialysis population, as reported by Stosovic et al. [9] and Tripepi et al. [10] respectively. LvE can be a sign of chronic Pressure and Volume overload, impaired Ventricular compliance and valvular dysfunction all of which can affect cardiovascular outcomes badly. Our study further corroborates the pathophysiological link between structural heart disease and mortality risk in MHD patients since both increased LAD and CVC were present.

The current study also found diabetes mellitus and pre-existing cardiovascular disease to be independent risk factors for mortality. Diabetes also was associated with >2-fold greater risk of all-cause mortality (HR=2.14) and >2.7-fold greater risk of cardiovascular mortality (HR=2.72), as was history of cardiovascular disease. They corroborate the known associations of diabetes and cardiovascular disease in ESRD patients. Further, both low hemoglobin levels and high β2-microglobulin levels independently predicted mortality, showing that both anemia and elevated chronic inflammation and low ability to clear middle molecular weight toxins contribute to cardiovascular risk.

Vitamin D therapy was an important protective factor we found in our study. Vitamin-D-treated patients had significantly reduced risks for all-cause mortality (HR=0.64, p=0.041) and cardiovascular mortality (HR=0.58, p=0.035). The present findings confirm the results of observational studies performed by Teng et al. [11] and Shoji et al. [12] that found higher survival rates in hemodialysis patients with active vitamin D analogues. Randomized trials have shown mixed results, but vitamin D could have beneficial effects on the cardiovascular system by regulating myocardial hypertrophy, inflammation, and mineral metabolism. These were also associated with lower albumin levels in patients with CVC (38.9 ± 3.4 vs. 40.6 ± 3.2 g/L, p=0.005) and the protective effect of albumin against all-cause mortality further highlights the role of nutritional/inflammatory status in long-term outcomes.

In conclusion, our results showed strong relation between cardiac valve calcification and cardiovascular complications and mortality in maintenance hemodialysis patients. Valvular calcification could therefore be considered as a simple and cost-effective screening method to classify risk, detect early individuals at high risk and apply targeted therapeutic interventions to decrease cardiovascular morbidity and mortality in this high-risk population.

Conclusion

This study showed that cardiac valve calcification is a significant predictor of cardiovascular complications and death in maintenance hemodialysis. The patients with cardiac valve calcification had elevated rates of all-cause mortality, cardiovascular mortality, major cardiovascular events, hospitalization for heart failure, acute coronary syndrome, stroke and higher prevalence of diabetes mellitus, pre-existing cardiovascular disease, and adverse cardiac structural changes when compared with patients without cardiac valve calcification. Cardiac valve calcification was identified as an independent predictor of all-cause and cardiovascular mortality, along with diabetes, a history of cardiovascular disease, left atrial enlargement, anemia, and elevated levels of β2-microglobulin, by multivariate analysis. On the other hand, vitamin D could be correlated with better prognosis of survival. The results indicate that cardiac valve calcification is not only a consequence of mineral metabolism disturbances, but also a significant cardiovascular risk indicator in hemodialysis patients. A possible advantage of routine echocardiographic surveillance for valvular calcification could therefore be the ability to identify high-risk individuals early in order to provide timely, preventive and therapeutic strategies to reduce cardiovascular morbidity and mortality in this vulnerable population.

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