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Relevance of cardiovascular risk factors in patients with terminal chronic kidney disease

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Acronyms
CKD: chronic kidney disease
HD: hemodialysis
RF: risk factors
LVH: left ventricular hypertrophy
DD: diastolic dysfunction

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ABSTRACT

Introduction: Cardiovascular disease is a significant comorbidity and, simultaneously, the leading cause of death in patients with chronic kidney disease.

Objective: To describe the association between risk factors and cardiovascular disease in patients on a continuous hemodialysis plan.

Method: A descriptive, longitudinal and retrospective study was conducted in 49 patients who participated in a continuous hemodialysis plan at the Calixto García Hospital in 2012. Odds ratio was used for the association between variables, with its confidence interval and Fisher's exact test.

Results: 83.7% of patients were hypertensive and 71.4% showed left ventricular hypertrophy. Old age was the risk factor most consistently associated with such hypertrophy [OR=4.35 (CI=1.03 to 18.37); p = 0.036]. The risk factors that were associated with diastolic dysfunction included hypertension [OR=9.88 (CI=1.11 to 87.90); p=0.021], diabetes mellitus [OR=12.94 (CI=1.49 to 112.44); p=0.006], and hypoalbuminemia [OR=4.67 (CI=1.09 to 19.90); p=0.030]. No risk factor was associated with mitral valve disease.

Conclusions: The most prevalent health condition was hypertension, and most of the population had left ventricular hypertrophy, which was associated with old age; just as hypertension, diabetes mellitus, and hypoalbuminemia were associated with diastolic dysfunction. No statistical association between mitral valve disease and any of the analyzed risk factors was found.

Key words: Chronic kidney disease, Cardiovascular disease, Risk factor, Hemodialysis

Relevancia de los factores de riesgo cardiovascular en pacientes con enfermedad renal crónica terminal

RESUMEN

Introducción: La enfermedad cardiovascular constituye una comorbilidad importante y a la vez, la primera causa de muerte en los pacientes con enfermedad renal crónica.

Objetivo: Describir la asociación entre los factores de riesgo y la enfermedad cardiovascular en pacientes en plan continuo de hemodiálisis.
Método: Estudio descriptivo, longitudinal y retrospectivo con 49 pacientes que participaron en el plan continuo de hemodiálisis del Hospital "Calixto García" en el 2012. Para la asociación de las variables se utilizó el índice de probabilidades (*odds ratio*), con su intervalo de confianza y la prueba exacta de Fisher.
Resultados: El 83,7 % de los pacientes fueron hipertensos y el 71,4 % tuvo hipertrofia del ventrículo izquierdo. La edad avanzada fue el factor de riesgo que más se asoció con dicha hipertrofia [*OR*=4,35 (IC=1,03-18,37); p=0.036]. Los factores de riesgo que se asociaron con la disfunción diastólica, fueron la hipertensión arterial [*OR*=9,88 (IC=1,11-87,90); p=0.021], la diabetes mellitus [*OR*=12,94 (IC=1,49-112,44); p=0.006] y la hipoalbuminemia [*OR*=4,67 (IC=1,09-19,90); p=0.030]. Ningún factor de riesgo se asoció con la valvulopatía mitral.
Conclusiones: El antecedente patológico más prevalente fue la hipertensión arterial y la mayor parte de la población tenía hipertrofia del ventrículo izquierdo, que se asoció con la edad avanzada; de la misma forma, la hipertensión arterial, la diabetes mellitus y la hipoalbuminemia se asociaron con la disfunción diastólica. No se encontró asociación estadística entre la valvulopatía mitral y ninguno de los factores de riesgo analizados.
Palabras clave: Enfermedad renal crónica, Enfermedad cardiovascular, Factor de riesgo, Hemodiálisis

INTRODUCTION

Patients with chronic kidney disease (CKD) have a very significant increase in cardiovascular morbidity and mortality compared to the general population. Between 40 and 75% of patients who begin the dialysis programs have cardiovascular disease, which is responsible for 44% of deaths of patients in this situation, and is the most important cause of cardiovascular morbidity and total mortality[1].

In Cuba, in 2010, 612 persons died due to kidney diseases, an amount that was increased in 2011 to a rate of 5.7 deaths per 100 thousand inhabitants. Cardiovascular diseases are the leading cause of death in this country, a situation which does not discriminate patients with CKD, where these diseases are also the leading cause of death[2].

The pathophysiological process that would explain the association of CKD with the development of cardiovascular diseases is very complex, a process in which high blood pressure (HBP), dyslipidemia, endothelial injury, alterations in calcium and phosphorus metabolism, and anemia are involved; also the increase in cardiac output secondary to the presence of arteriovenous fistulae in patients having criterion for hemodialysis (HD), increases cardiovascular morbidity in this kind of patients[1,3].

In general, cardiovascular risk factors (RF) in patients with end-stage CKD can be grouped into three main groups:

Classical or traditional cardiovascular RF

Those cardiovascular RF common to the general population such as: older age, male sex, hypertension, diabetes mellitus, dyslipidemia, smoking, family history of cardiovascular disease, physical inactivity and left ventricular hypertrophy (LVH)[1,4-9].

RF specific of uremia

Those that depend on the actual pathophysiology of CKD such as: anemia, altered calcium-phosphorus metabolism, hyperhomocysteinemia, oxidative stress, early menopause, malnutrition, sleep disturbances and hypoalbuminemia[1,4].

Dialysis-related RF

Those parameters typical of the HD procedure that increase cardiovascular risk. Among them is the type of dialysis liquid, poor patient tolerance, inadequate dialysis dose, volume overload that occurs in it, the time with HD and the presence of arteriovenous fis-

tula[1,4].

Identifying the major cardiovascular RF could guide the physician to the early identification of patients at high risk for a cardiovascular disorder, and secondarily, to develop strategies to reduce its appearance, which would lead to long-term decline in mortality from cardiovascular diseases in patients with CKD. The aim of this study was to describe the association between cardiovascular RF and certain cardiovascular disorders such as LVH, diastolic dysfunction (DD) of the left ventricle and mitral valve disease in patients on a continuous plan of HD.

METHOD

A descriptive, longitudinal and retrospective study was conducted in patients diagnosed with end-stage CKD who participated in the continuous hemodialysis plan of the Nephrology Service of the General Calixto García Iñiguez Clinical-Surgical Hospital during 2012.

The population consisted of 49 patients who met the inclusion criteria.

Inclusion criteria

Patients of both sexes, aged over 18 years, with CKD undergoing hemodialysis who presented any cardiovascular abnormality detected by echocardiography.

It was not necessary to obtain a sample since we worked with the whole population.

Demographic, clinical, biochemical and echocardiographic variables were analyzed.

For statistical analysis the software SPSS version 22 was used and Fisher's exact test was applied as well as the odds ratio (OR) with its confidence interval (CI) with 95% confidence level. The OR values> 1 that were within the given interval with 95% confidence, which should not contain the unit, and values of p <0.05 were considered as a statistically significant positive association.

Ethical Issues

Subject to the approval of the research protocol we proceeded to collect data from medical records and metabolic control sheets of selected patients. Records excluded personal identity data, so that the established bioethical parameters for the use of medical records were met.

RESULTS

The main cardiovascular changes were LVH which was found in 71.4% of patients, heart failure (57.1%) and valvular heart disease (51%). It should be noted that several patients had more than one cardiovascular change (**Table 1**).

Table 1. Cardiovascular disorders present in patients of the continuous hemodialysis (HD) plan at the Calixto García Iñiguez Clinical-Surgical Hospital, in 2012 (n=49).

Cardiovascular disorders	Nº	%
Left ventricular hypertrophy	35	71,4
Enlargement of cavities		
Left atrium	5	10,2
Left ventricle	2	4,1
Right atrium	5	10,2
Right ventricle	5	10,2
Valve disease	25	51
Aortic	9	18,4
Mitral	20	40,8
Pulmonary	3	6,1
Tricuspid	18	36,7
Heart failure	28	57,1
Diastolic	25	51,0
Systolic	3	6,1
Pericardial thickening	15	30,6
Pulmonary hypertension	14	28,4
Hypertensive heart disease	14	28,6
Ischemic heart disease	17	34,7

Source: Medical Records

Table 2 shows that predominating ages were between 40-49 (29.4%) and 50-59 (24.5%) years. Similarly it is observed that males predominated with 63.3%. The most prevalent antecedent was hypertension, which was present in 85% of patients with heart failure, in 80% of patients with valvular heart disease, in 71.4% of those with PH and 82.4% of those with coro-

Table 2. Demographic and clinical characteristics.

Variables	Population (n=49)		HF (n=28)		Valve disease (n=25)		PH (n=14)		IHD (n=17)	
	Nº	%	Nº	%	Nº	%	Nº	%	Nº	%
Age										
20-29	1	2,0	0	0,0	1	4,0	0	0,0	0	0,0
30-39	7	14,3	2	7,1	2	12,0	2	14,3	1	5,9
40-49	10	29,4	6	21,4	5	20,0	2	14,3	3	17,6
50-59	12	24,5	8	28,6	7	28,0	5	35,7	7	41,2
60-69	9	18,4	5	17,9	3	12,0	2	14,3	1	5,9
70-79	9	18,4	6	21,4	6	24,0	3	21,4	5	29,4
80-89	1	2,0	1	3,6	0	0,0	0	0,0	0	0,0
Sex										
Female	18	36,7	11	39,3	12	48,0	6	42,9	8	47,1
Male	31	63,3	17	60,7	13	52,0	8	57,1	9	52,9
Skin color										
White	16	32,7	9	32,1	8	32,0	3	21,4	5	29,4
Mixed-race	12	24,5	8	28,6	6	24,0	5	35,7	2	11,8
Black	21	42,9	11	39,3	11	44,0	6	42,9	10	58,8
PPA										
HBP	41	83,7	24	85,7	20	80,0	10	71,4	14	82,4
DM	10	20,4	9	32,1	5	20,0	0	0,0	3	17,6
IHD	7	14,3	6	21,4	6	24,0	3	21,4	5	29,4
Dyslipidemia	21	42,9	13	46,4	10	40,0	5	35,7	5	29,4
Hepatitis	37	75,5	23	82,1	21	84,0	13	92,9	13	76,5
Causes of CKD										
HBP	21	42,9	10	35,7	8	32,0	8	57,1	7	41,2
DM	9	18,4	8	28,6	5	20,0	0	0,0	2	11,8
IHD	1	2,0	1	3,6	1	4,0	0	0	0	0
Obstructive nephropathy	7	14,3	4	14,3	3	12,0	2	14,3	4	23,5
Others	11	22,4	5	17,8	8	32	4	28,6	4	23,5
Time on HD (years, mean)	2,81		2,98		3,25		4,40		2,29	

Caption. IHD: ischemic heart disease, DM: diabetes mellitus, HBP: high blood pressure, PH: pulmonary hypertension, HF: heart failure

nary artery disease.

Patients with PH had higher mean creatinine figures (724.03 mmol/L), and those suffering from ischemic heart disease had lower figures of albumin (40.26 mmol/L) (**Table 3**).

Table 4 shows that older age was significantly associated with the occurrence of LVH (OR =4.35, p=0.036).

96% of patients who had DD were hypertensive (**Table 5**), hence a risk 9 times higher in this population is observed (OR = 9.88, P = 0.021); in addition, 9 of 10 diabetic patients had DD (OR = 12.94, P = 0.006).

Although 90% of patients with mitral valve disease had anemia (OR = 0.32, p = 0.361), and 89.7% of those who did not have it presented arteriovenous fistula (OR = 0, 27, p = 0.086), no significant statistical association of this variable with any of the RF analyzed was found (**Table 6**).

DISCUSSION

CKD is currently recognized as a condition which can increase the risk of cardiovascular disease. Renal impairment or end stage CKD is its stage of highest risk [5]. This excess cardiovascular risk is partly attributed to an increase of RF that are commonly found in patients with CKD, including hypertension, diabetes, dyslipidemia, older age, lifestyle, physical inactivity and smoking; but perhaps they are also related with structured and functional abnormalities of the heart, in these patients[6].

Table 3. Biochemical characteristics.

Variables (mean)	Population	HF	Valvulopathy	PH	IHD
Creatinine (µmol/L)	712,23	719,25	680,23	724,03	696,05
Uric Acid (mmol/L)	356,47	353,82	349,74	345,78	348,24
PT (mmol/L)	76,06	74,38	75,39	76,93	74,01
Albumin (mmol/L)	44,22	44,09	43,14	44,01	40,26
Cholesterol (mmol/L)	4,47	4,54	4,64	4,32	4,41
Triglycerides (mmol/L)	1,72	1,78	1,74	1,77	1,70
Hematocrit (%)	0,33	0,33	0,32	0,32	0,32
Glucose (mmol/L)	5,78	6,39	6,00	5,12	5,33
Serum calcium (mmol/L)	2,30	2,29	2,29	2,35	2,21

Caption. IHD: ischemic heart disease, PH: pulmonary hypertension, HF: heart failure

Table 4. Association between cardiovascular RF and LVH.

Risk Factors	LVH				OR (CI)	p
	Yes (n=35)		No (n=14)			
	Nº	%	Nº	%		
Traditionals						
Older age	19	54,3	3	21,4	4,35 (1,03 - 18,37)	0.036
Male sex	21	60,0	10	71,4	0,60 (0,16 - 2,29)	0.341
HBP	31	88,6	10	71,4	3,10 (0,65 - 14,73)	0.150
DM	9	25,7	1	7,1	4,50 (0,51 - 39,44)	0.143
Dyslipidemia	17	48,6	11	78,6	0,26 (0,61 - 1,08)	0.053
CKD-specific						
Anemia	33	94,3	13	92,9	1,27 (0,11 - 15,23)	0.645
Hypercalcemia	3	8,6	0	0,0	-	0.355
Early menopause	2	5,7	0	0,0	-	0.506
Hypoalbuminemia	11	31,4	2	14,3	2,75 (0,52 - 14,44)	0.195
HD-dependant						
AV fistula	28	80,0	12	85,7	0,67 (0,12 - 3,69)	0.493
Time> 1 Year	27	77,1	12	85,7	0,56 (0,10 - 3,05)	0.403

Caption. AV: arteriovenous, DM: diabetes mellitus, HBP: high blood pressure, LVH: left ventricular hypertrophy, CI: confidence interval, OR: odds ratio.

Ventura *et al.*[7] and Barjadí *et al.*[8] agree that LVH is a common cardiovascular RF in patients with CKD, as it develops from early stages and increases its prevalence with advanced stages. Our study confirms the above mentioned, as the main cardiovascular abnormality found was LVH. This is also corroborated by Rodriguez Batista in his study "*Prevalencia de FR cardiovascular en pacientes con enfermedad renal crónica*" (Prevalence of cardiovascular RF in patients with chronic kidney disease) in which he found that the main cardiac change in his series was LVH[4].

Male sex predominated in this study, which coincides with Grigorian and colleagues[10], who analyzed 552 patients between 2000 and 2002, where they found that men were the most affected and showed that renal failure was a factor that increased mortality risk in patients with cardiac failure[10]. Furthermore, it has been observed that in the United States patients with CKD have increased dramatically from 209,000 in 1991 to 472,000 in 2004, within these the majority were male; this increase may be an important RF for these patients as it is known that cardiovascular diseases affect mostly men[11].

A major cause of CKD is hypertension, second only to diabetes mellitus, and in many studies it has proven to be the

most prevalent antecedent and the leading cause of CKD. Díaz *et al*.[13] coincide with our results, they found that hypertension was the leading cause of CKD in the Nephrology Department of the Tunas.

Creatinine is the most commonly used test for renal function but not the most reliable one because it has been overtaken by the quantification of the glomerular filtration rate, which is inversely proportional to creatinine[14,15]. Furthermore, according to Schiffrin *et al*.[16], studies such as the Framingham and HOPE have shown a clear association between decreased renal function, as evidenced by high creatinine levels or low glomerular filtration rate, with cardiovascular risk.

In this study the association of RF with certain cardiac abnormalities (LVH, DD of LV and mitral valve disease) which are common in these patients was analyzed.

It was noted that most patients with LVH were male, hypertensive and in advanced ages. The mechanisms involved in the development of this complication are: pressure and volume overload, secondary hyperparathyroidism, and activation of the renin-angiotensin system. Pressure overload is induced by hypertension, the stiffness of large arteries (arteriosclerosis) or aortic valve disease, which leads to the development of concentric LVH. In turn, fluid overload is induced by chronic hypervolemia, anemia or hyperdynamic circulation generated by vascular access, which in most cases is an arteriovenous fistula, which is associated with an increased cardiac output and enhances the development of an eccentric LVH[16,17].

Eckardt *et al*.[18] in their studies for assessing the risk of LVH and survival in patients with the disease, found no statistical association in the multivariate analysis performed with binary logistic regression among older age, sex and presence of LVH, data which coincide with our results in relation to sex, but not in relation to age, as in this study older age was indeed associated with LVH. This is attributable to the fact that elderly patients, in addition to having the proper remodeling of systolic and diastolic overload, present atherosclerotic changes typical of aging that contribute to vascular stiffness and thus to systolic overload[18]. Most of the patients studied were hypertensive, which influenced our results, as this condition prevailed in those with LVH and in those who did not have it. Hypertension in patients with CKD has several origins, its appearance may be due to volume overload, autonomous hyperfunction and the effects of renin-angiotensin-aldosterone system, all of which promote ventricular remodeling[8,17-20].

There is an inverse relationship between hemoglobin levels and left ventricular mass in patients on dialysis and in those who have undergone kidney transplant, which entails that anemia contributes to the development of this complication, as it is capable of causing CF with high cardiac output, which could become chronic in patients with chronic kidney diseases[17]. In this study no association was found between

Table 5. Association between cardiovascular RF and diastolic dysfunction.

Risk factors	Diastolic dysfunction				OR (CI)	p
	Yes (n=25)		No (n=24)			
	Nº	%	Nº	%		
Traditionals						
Older age	12	48,0	10	41,7	1,29 (0,48 - 3,99)	0.437
Male sex	14	56,0	17	70,8	0,524 (0,16 - 1,71)	0.218
HPB	24	96,0	17	70,8	9,88 (1,11 - 87,90)	**0.021**
DM	9	36,0	1	4,2	12,94 (1,49 - 112,44)	**0.006**
Dyslipidemia	12	48,0	16	66,7	0,46 (0,14 - 1,47)	0.151
LVH	20	80,0	15	62,5	2,40 (0,67 - 8,65)	0.175
CKD-specific						
Anemia	22	88,0	24	100	-	0.125
Hypercalcemia	2	8,0	1	4,2	2,00 (0,17 - 23,62)	0.516
Early menopause	2	8,0	0	0,0	-	0.255
Hypoalbuminemia	10	40,0	3	12,5	4,67 (1,09 – 19,90)	**0.030**
HD-dependant						
AV fistula	19	76,0	21	87,5	0,45 (0,99 – 2,06)	0.253
Time> 1 Year	21	84,0	18	75,0	1,75 (0,43 – 7,19)	0.335

Caption. AV: arteriovenous, DM: diabetes mellitus, HBP: high blood pressure, LVH: left ventricular hypertrophy, CI: confidence interval, OR: odds ratio.

chronic anemia (or of other specific RF specific of CKD) and LVH. Our study agrees with the results of Eckardt *et al*.[18], who did not find either a significant association in the multivariate analysis.

Other factors that have been implicated in the development of LVH are secondary hyperparathyroidism (parathyroid hormone is a facilitator agent of cardiac myocytes growth), activation of the local renin-angiotensin system and endothelin-1, sympathetic overactivity, sleep apnea, inflammation, hyperhomocysteinemia, elevated levels of asymmetric dimethylarginine, or valvular or vascular calcification, among others[17].

This study found that most patients had arteriovenous fistula regardless of the presence of LVH, which could have affected our results, since no statistical association was found. It has been shown that arteriovenous fistulas increase myocardial work and favor the development of high-output heart failure, which in turn is associated with the presence of LVH [8,16,17].

Alterations in LV function play an important role in cardiovascular morbidity and in mortality in patients with CKD. DD occurs because there is an increase in ventricular mass and fibrosis, which leads to decreased myocardial compliance and cardiac adaptability; this is a determining factor in the occurrence of intradialytic hypotension, and is related to the genesis of cardiac arrhythmias in uremic patients, consequently it can lead to sudden death. However, systolic dysfunction is clinically manifested by congestive heart failure and cardiac rhythm disturbances[21].

This study found that most patients with DD were hypertensive. It is known that chronic pressure overload contributes to myocardial dysfunction. Our results agree with Masugata *et al*.[22], who found a high statistical association between hypertension and DD (p<0.001).

Diabetes is an extensively studied cardiovascular RF due to its prognostic relationship. It also plays an important role in patients with terminal CKD. So, Muntner *et al*.[23] suggest that diabetics have a probability 2.88 times higher to have a cardiovascular event [HR= 2,88 (IC: 1,85-4,47)].

Diabetes is the most common cause of terminal CKD and is associated not only with hypertension but also with hypertriglyceridemia, hypercholesterolemia, HVI and hyperfibrinogenemia. Moreover, CKD, regardless of diabetes, is associated with some insulin resistance and impaired glucose tolerance. Both factors favor the accumulation of glycosylation end products which can cause endothelial damage and accelerated atherogenesis. All these factors are related to impaired cardiac function[17].

In this study, a statistically significant association between diabetes mellitus and DD was found, which is consistent with Barberato *et al*.[24], who found a high ratio of diabetic patients with discrete and advanced DD, with p = 0.019. Also, Shah *et al*.[25], in a retrospective study of 274 patients, found that a his-

Table 6. Association between cardiovascular RF and mitral valve disease.

Risk factors	Mitral valve disease				OR (CI)	p
	Yes (n=20)		No (n=29)			
	Nº	%	Nº	%		
Traditionals						
Older age	9	45,0	13	44,8	1,01 (0,32 – 3,16)	0.609
Male sex	10	50,0	21	72,4	0,38 (0,11 – 1,26)	0.097
HPB	15	75,0	26	89,7	0,35 (0,72 – 1,66)	0.166
DM	5	25,0	5	17,2	1,60 (0,39 – 6,47)	0.377
Dyslipidemia	12	60,0	16	55,2	1,22 (0,38 – 3,87)	0.484
LVH	14	70,0	21	72,4	0,89 (0,25 – 3,12)	0.551
CKD-specific						
Anemia	18	90,0	28	96,6	0,32 (0,27 – 3,81)	0.361
Hypercalcemia	1	5,0	2	6,9	0,71 (0,60 – 8,41)	0.639
Early menopause	2	10,0	0	0,0	-	0.162
Hypoalbuminemia	7	35,0	6	20,7	2,06 (0,57 – 7,46)	0.215
HD-dependant						
AV fistula	14	70,0	26	89,7	0,27 (0,58 – 1,24)	0.086
Time> 1 Year	17	85,0	22	75,9	1,80 (0,40 – 8,03)	0.343

Caption. AV: arteriovenous, DM: diabetes mellitus, HBP: high blood pressure, LVH: left ventricular hypertrophy, CI: confidence interval, OR: odds ratio

tory of diabetes mellitus had prognostic relationship with the occurrence of cardiovascular events (OR = 2.83, p = 0.001).

In this research, a certain relationship between menopause and the presence of DD was also found, but with no statistically significant association. It is known that women have certain cardiovascular protection until a certain age, but once these women enter menopause they lose such protection due to the decrease in their sex hormones. All this increases the risk of cardiovascular disease in menopausal women; regarding the relationship of this with the appearance of DD no studies assessing this association were found.

Although in this study no relationship between LVH and DD was found, it is important to clarify that the literature presents LVH as the great traditional RF for the loss of heart function. LVH begins as an adaptive phenomenon to pressure and/or volume overload, but in the long term it becomes a maladaptive phenomenon. LVH, the concentric form in particular, is associated with decreased left ventricular adaptability, which leads to DD. Firstly, hypervolemia can more easily lead to a pressure increase in the left atrium and predispose to pulmonary edema; and second, a reduction of the filling pressure, for example during ultrafiltration in HD, predisposes to a sharp drop of this and favors the development of intradialytic hypotension[17].

Within the specific RF of uremia only an association between hypoalbuminemia and DD was found. Collado *et al*.[26] found that the majority of HD patients who developed cardiovascular disease had hypoalbuminaemia for p = 0.053. Furthermore, Barberato *et al*.[25] found no association between the presence of mild and severe DD.

When analyzing the association of RF with the presence of mitral valve disease no significant associations were obtained. The annular calcification is especially common in patients with advanced renal disease and is frequently seen in elderly women with hypertension and diabetes[27].

Leiskinen *et al*.[28] in their multivariate analysis found that the main RF of mitral valve calcification in HD patients were older age, increased levels of interleukin 6 and duration of dialytic treatment, variables that in this study were not associated with mitral valve disease. Similarly, Rao *et al*.[29] observed that calcification of the mitral valve in patients with CKD is also associated with calcification and stiffness of the intima of the carotid artery, with decreased ventricular function and with inflammatory conditions that are observed in these patients.

CONCLUSIONS

Older age was the RF with the highest statistical association for LVH. For DD risk factors were: hypertension, diabetes mellitus and hypoalbuminemia. No statistical association between mitral valve disease and any of the risk factors analyzed was found.

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