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ORIGINAL

Detection and evaluation of vascular calcifications using Duplex Doppler ultrasound, in patients with Chronic Kidney Disease at the Centro Integral Hemodialisis y Trasplantes S.R.L. in Tarija Bolivia

Detección y evaluación de calcificaciones vasculares mediante ultrasonido Doppler Dúplex, en pacientes con Enfermedad Renal Crónica en el Centro Integral Hemodiálisis y Trasplantes S.R.L. en Tarija Bolivia

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ABSTRACT

Introduction: Chronic Kidney Disease represents a systemic pathology with important consequences on patient survival, mainly through the development of vascular calcifications. Early detection of these calcifications is crucial for the assessment of cardiovascular risk and timely therapeutic management. The present study aims to evaluate the usefulness of Duplex Doppler ultrasound in the detection and evaluation of vascular calcifications in patients with CKD.
Methods: Study design. Descriptive observational, which was carried out at the Centro Integral Hemodialisis y Trasplantes S.R.L. in Tarija, Bolivia. The research universe was 60 patients with Chronic Kidney Disease, who undergo hemodialysis at the Center, the sample was 32 patients, selected according to inclusion and exclusion criteria. Exclusion Criteria: Any patient who does not meet the

inclusion criteria. Inclusion Criteria: Patients with CKD who undergo Hemodialysis at Centro Integral Hemodialisis y Trasplantes S.R.L.
Results: Table 1 shows that, of 32 patients, the predominant age group is 61 to 70 years. The presence of chronic diseases is evident in patients with CKD, with arterial hypertension and type II diabetes mellitus being the most frequent. Table 3 shows that of the total number of patients in the study population, 75% had a mild vascular calcification score (0-25 points), 21.87% had a moderate vascular calcification score (26-39 points), and only 3.12% had a severe score (40-63 points).
Conclusions: Duplex Doppler ultrasound is a noninvasive, safe and effective technique for the evaluation of vascular calcifications in patients with chronic kidney disease. Its ability to detect subtle changes in arterial morphology allows for early diagnosis and better management of cardiovascular risk. The presence of vascular calcifications in patients with CKD increases cardiovascular risk.
Keywords: Chronic kidney disease, vascular calcifications, Duplex Doppler ultrasound, cardiovascular risk.

RESUMEN

Introducción: La Enfermedad Renal Crónica representa una patología sistémica con importantes consecuencias sobre la supervivencia de los pacientes, principalmente a través del desarrollo de calcificaciones vasculares. La detección temprana de estas calcificaciones es crucial para la evaluación del riesgo cardiovascular y el manejo terapéutico oportuno. El presente estudio tiene como objetivo evaluar la utilidad del ultrasonido Doppler Dúplex en la detección y evaluación de calcificaciones vasculares en pacientes con ERC.
Métodos: Diseño del estudio. Observacional descriptivo, el cual se realizó en el Centro Integral Hemodiálisis y Trasplantes S.R.L. en Tarija, Bolivia. El universo de la investigación fue de 60 pacientes con Enfermedad Renal Crónica, que se realizan hemodiálisis en el Centro, la muestra fue de 32 pacientes, seleccionados según criterios de inclusión y exclusión. Criterio de Exclusión: Todo paciente que no cumpla con los criterios de inclusión. Criterios de Inclusión: Pacientes con ERC que se realiza Hemodiálisis en Centro Integral Hemodiálisis y Trasplantes S.R.L.
Resultados: En la Tabla 1 se evidencia que, de 32 pacientes, el grupo de edad predominante es de 61 a 70 años. Se evidencia la presencia de enfermedades crónicas, presentes en pacientes con ERC, siendo la Hipertensión Arterial y la Diabetes Mellitus tipo II, las más frecuentes. La Tabla 3, muestra que del total de pacientes de la población estudiada, el 75% presento un puntaje de calcificación vascular leve (0-25 puntos), el 21.87%% presento un puntaje de calcificación vascular moderado (26-39 puntos), y solo el 3.12%, presento un puntaje severo (40-63 puntos).
Conclusiones: El ultrasonido Doppler dúplex se presenta como una técnica no invasiva, segura y efectiva para la evaluación de calcificaciones vasculares en pacientes con enfermedad renal crónica. Su capacidad para detectar cambios sutiles en la morfología arterial permite un diagnóstico temprano y un mejor manejo del riesgo cardiovascular. La presencia de calcificaciones vasculares en pacientes con ERC, aumenta el Riesgo Cardiovascular.
Palabras clave: Enfermedad renal crónica, calcificaciones vasculares, ultrasonido Doppler Dúplex, riesgo cardiovascular.

INTRODUCTION

Chronic kidney disease-mineral and bone disease (CKD-MBD) is a systemic pathology with significant consequences for patient survival, mainly through the development of vascular calcifications1,2. Early detection of these calcifications is crucial for cardiovascular risk assessment and timely therapeutic management3. Vascular calcifications in patients with CKD are a serious complication that significantly impacts their prognosis and quality of life4.

According to data from the Pan American Health Organization, kidney diseases, including CKD due to diabetes mellitus and arterial hypertension, are among the leading causes of mortality and disease burden in the Region of the Americas5. Significaagingctional and organic changes, including thickening of the intima-media complex, arterial dilation, and deterioration of the elastic properties of the vascular wall6,7, characterize vascular aging associated with CKD.

The presence of vascular calcifications in large arteries is more prevalent in dialysis patients than in controls, predominantly located linearly in the intima of the arteries7,8; their focal or diffuse distribution in different arterial segments will depend on the stage and time of the disease or convalescent cause. This pathological process requires early detection and evaluation, ideally in stages G3 or G4 of CKD, to allow for timely intervention that can modify the course of the disease5. Despite the availability of various diagnostic methods, such as Computed Axial Tomography (CAT) with advanced volumetric reconstruction techniques with renal and urinary tract protocols and conventional radiography, there is a pressing need for accessible, non-invasive, and lower-cost tools for the routine evaluation of vascular calcifications in patients with CKD9. Duplex Doppler ultrasound is emerging as a promising alternative, standing out for its advantages of mobility, speed, low cost, accessibility, and absence of radiation10 with only one disadvantage: being operator dependent. However, no standardized protocol exists for its application in this specific context.

Arterial elasticity, the first factor altered by the presence of vascular calcifications, can be evaluated by physically interpreting the morphology of the spectral wave using duplex Doppler ultrasound11. This technique allows changes to be observed in the regular triphasic wave pattern (renal arteries) (anterograde monophasic and low resistance, with velocities that decrease as the renal artery divides), providing valuable information on the patient's vascular status through the resistance index values with expected values of 0.55-0.7. The objective of the present study is to evaluate the usefulness of duplex Doppler ultrasound in detecting and evaluating vascular calcifications in patients with CKD. Considering the significant impact of cardiovascular calcifications and, therefore, cardiovascular complications on the mortality of patients with Chronic Kidney Disease, this approach has the potential to positively impact medical practice by proposing an innovative and accessible methodology for these patients. In addition, it seeks to contribute to the early diagnosis and more accurate assessment of cardiovascular risk in this vulnerable population.

METHODS

Study design. A descriptive observational study was conducted at the Centro Integral Hemodiálisis y Trasplantes S.R.L. in Tarija, Bolivia. The research universe was 60 patients with Chronic Kidney Disease who undergo hemodialysis at the Center; the sample was 32 patients, selected according to inclusion and exclusion criteria. **Exclusion Criteria:** Any patient who does not meet the inclusion criteria. **Inclusion criteria:** Patients with CKD who undergo hemodialysis at Centro Integral Hemodiálisis y Trasplantes S.R.L. Patients who are physically and mentally fit. Patients who give their consent to participate in this study. **Research instruments:** Structured interviews with specialists, demographic and clinical surveys of patients, and Doppler duplex ultrasound evaluation protocol.

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Ultrasonographic evaluation. The evaluation was carried out using duplex Doppler ultrasound, assessing the extent of calcifications, affected arterial wall, stenosis diameter, and characteristics of the spectral wave morphology. Prior to the evaluation of each patient, the main technical parameters of the equipment were configured for pulsed or spectral Doppler mode, such as pulse repetition frequency (PRF)/velocity scale, sample volume size, gain, angle of incidence, baseline and wall filter, to avoid aliasing and other artifacts during the study. Once the ultrasound evaluation for the identification and evaluation of vascular calcifications in patients with Chronic Kidney Disease had been completed, using the Statistical Method, all the data collected during the evaluations was analyzed and processed. The results obtained from the evaluation were interpreted to obtain an overall score. The Statistical Method was also used to characterize the study population.

RESULTS

In Table 1, which distributes the patients according to age groups, it can be seen that of 32 patients, the predominant age group is 61 to 70 years, with 11 patients, or 34.4%, in second place is the 51 to 60 age group with 10 patients, or 31.3%, and in third place is the 30 to 40 years old with four patients, 12.5%. The distribution of patients in age groups allows the population to be segmented and provides a more general view of the predominant age group in the population studied. In this case, it was the age group from 61 to 70 years of age who suffer from Chronic Kidney Disease and undergo Hemodialysis at the Centro Integral Hemodiálisis y Trasplantes S.R.L.

Table 1. Distribution of patients with Chronic Kidney Disease, by age. Centro Integral Hemodiálisis y Trasplantes S.R.L.

Table 1. Age distribution of patients with Chronic Kidney Disease

Age group	N° of patients	%
30-40	4	12.5
41-50	3	9.4
51-60	10	31.3
61-70	11	34.4
71-80	3	9.4
81-90	1	3
Total	**32**	**100**

Source: Survey form for patients with CKD.

Figure 1 shows the distribution of patients by sex, where the predominance of males in the study population can be seen, with 24 patients representing 75% of the total number of patients, followed to a lesser extent by females, with only eight patients representing 25%. There is a clear predominance of males in the study population of patients with chronic kidney disease who undergo hemodialysis at the Centro Integral Hemodiálisis y Trasplantes S.R.L. This is consistent with the literature consulted, where the Pan American Health Organization explains that in 2021, in most countries, the mortality rate from kidney disease was higher in men than women.

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Figure 1. Distribution of patients by sex.

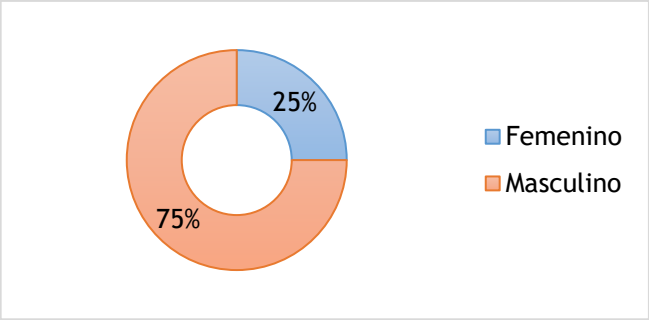

Table 2 shows the presence of chronic diseases in patients with CKD who undergo hemodialysis at the Centro Integral Hemodiálisis y Trasplantes S.R.L. Arterial hypertension and type II diabetes mellitus are the most frequent, present in 25 and 16 patients, respectively. The findings that AHT and type II DM are the chronic diseases most commonly present in patients with CKD undergoing hemodialysis at the Centro Integral Hemodiálisis y Trasplantes S.R.L. could be related to the reviewed literature, where the Pan American Health Organization, in 2021, states that Kidney Diseases (KD), including Acute Glomerulonephritis, CKD due to diabetes, CKD due to hypertension, and other CKDs, are among the leading causes of mortality and disease burden in the Region of the Americas.

Table 2. Distribution of patients with Chronic Kidney Disease, according to Associated Chronic Diseases.

Chronic Illness	N°
High blood pressure	25
Type II Diabetes Mellitus	16
Type I Diabetes Mellitus	1
Hyperparathyroidism	1
Systemic Lupus Erythematosus	1

Source: Questionnaires applied to patients with CKD, at the Centro Integral Hemodiálisis y Trasplantes S.R.L.

Table 3 shows that, of the 32 patients, which constitutes 100% of the study population, 75% had a mild vascular calcification score (0-25 points), 21.87% had a moderate vascular calcification score (26-39 points), and only 3.12% had a severe score (40 -63 points). It is also evident that 32 patients with Chronic Kidney Disease at the Centro Integral Hemodiálisis y Trasplantes S.R.L. who undergo Hemodialysis, all present to a greater or lesser extent, vascular calcifications, mainly of the mild type, which could be related to what Coll B. Et Al. State, where it is assumed that vascular calcification in large arteries is more prevalent in patients on dialysis than in controls and is predominantly located linearly in the intima of the arteries, that is to say, that linear vascular calcifications are more frequently observed, which, added to a smaller extent, would explain why the present study has shown a prevalence of mild vascular calcification. This score, based on an evaluation of vascular calcifications according to their extent, the arterial wall affected, the diameter of the stenosis, if any, and the characteristics of the morphology of the spectral wave on the Duplex Doppler, has its origin in the evaluation table, which is the final point where the data obtained by the Duplex Doppler evaluation are downloaded, using the protocol proposed for their respective validation.

Table 3. Detection and Evaluation of Vascular Calcifications Using Duplex Doppler Ultrasound in Patients with Chronic Kidney Disease, using the vascular calcification score evaluation table.

Vascular Calcification Score	N° patients	%
Mild	24	75
Moderate	7	21.9
Severe	1	3.1
Total	**32**	**100**

Source: Questionnaires applied to patients with CKD, at the Centro Integral Hemodiálisis y Trasplantes S.R.L.

CONCLUSIONS

Duplex Doppler ultrasound is a non-invasive, safe, and effective technique for evaluating vascular calcifications in patients with chronic kidney disease. Its ability to detect subtle changes in arterial morphology allows for early diagnosis and better cardiovascular risk management. The presence of vascular calcifications in patients with CKD increases cardiovascular risk. Patients suffering from Chronic Kidney Disease and undergoing Hemodialysis at the Centro Integral Hemodiálisis y Trasplantes S.R.L were evaluated with Doppler duplex ultrasound. 75% presented mild vascular calcifications, 21.9% moderate, and only 3% severe. Arterial hypertension and type II diabetes mellitus are the most commonly associated chronic diseases.

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