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ORIGINAL ARTICLE

Clinical and epidemiological profile of patients undergoing arteriovenous fistula in a hospital in Belo Horizonte

Perfil clínico e epidemiológico dos pacientes submetidos à confecção de fístula arteriovenosa em Belo Horizonte

Antonietta Saldanha Alves Bortolone Merlo[1], Ana Luíza Ferreira Silva[1], Paula Cardoso Diniz Messias[1], Flávio Mendonça Pinto[1]

ABSTRACT

Introduction and Objective: Chronic kidney disease is a significant public health issue. Treatment involves managing underlying diseases and contributing factors; however, many patients progress to the need for renal replacement therapy, such as hemodialysis, with the arteriovenous fistula (AVF) being the ideal vascular access. Our objective was to analyze the clinical and epidemiological profile of patients undergoing AVF creation for hemodialysis. **Methods:** Cross-sectional study based on the analysis of medical records of patients who underwent AVF creation at a University Hospital in Belo Horizonte between July and November 2023. **Results:** A total of 40 individuals (25 men) were included. The main risk factors found were arterial hypertension (90%) and diabetes (57.5%). The majority of AVFs were radiocephalic (55%), followed by brachiocephalic (37.5%) and brachioaxillary (7.5%), with the left upper limb being the most used. Eleven individuals presented complications after surgery. Only 12 individuals were undergoing renal replacement therapy before AVF creation. There was a significant difference between prior renal replacement therapy and creatinine levels (p=0.030), hematocrit (p=0.041), and serum sodium levels (p=0.017). **Conclusion:** There is a high prevalence of comorbidities such as diabetes and hypertension among individuals with chronic kidney disease undergoing AVF creation. The significant correlation between prior hemodialysis and certain laboratory parameters underscores the importance of early identification and proper management of comorbidities to enhance clinical outcomes and improve the quality of life for these patients.

Keywords: Chronic kidney disease; Arteriovenous fistula; Renal replacement therapy.

[1] Departamento de Medicina, Faculdade Ciências Médicas de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil.

Editor responsible:

Enio Roberto Pedroso

Faculdade de Medicina da Universidade Federal de Minas Gerais.

Belo Horizonte/MG, Brazil.

Corresponding author:

Flávio Mendonça Pinto

Departamento de Medicina, Faculdade Ciências Médicas de Minas Gerais, Minas Gerais.

E-mail: flaviomendocapinto64@gmail.com

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The authors declare no conflict of interest.

RESUMO

Introdução e Objetivo: A doença renal crônica é um relevante problema de saúde pública. O tratamento envolve o controle das doenças de base e dos fatores contribuintes, entretanto muitos pacientes evoluem com a necessidade de terapia renal substitutiva, como a hemodiálise, sendo a fístula arteriovenosa (FAV) o acesso vascular ideal. Nosso objetivo foi analisar o perfil clínico e epidemiológico dos pacientes submetidos à confecção da FAV para hemodiálise. **Métodos:** Estudo transversal, a partir da análise de prontuários de pacientes que realizaram a confecção de FAV em um Hospital Universitário de Belo Horizonte entre julho e novembro de 2023. **Resultados:** Foram incluídos 40 indivíduos (25 homens). Os principais fatores de risco encontrados foram hipertensão arterial (90%) e diabetes (57,5%). A maioria das FAVs foi radiocefálica (55%), seguida por braquiocefálica (37,5%) e braquiaxilar (7,5%), sendo o membro superior esquerdo o mais utilizado. Onze indivíduos apresentaram complicações após a cirurgia. Apenas doze indivíduos realizavam TRS antes da confecção da FAV. Houve uma diferença significativa entre a TRS prévia e os valores de creatinina (p=0.030), hematócrito (p=0.041) e sódio sérico (p=0.017). **Conclusão:** Há uma alta prevalência de comorbidades como diabetes e hipertensão entre os indivíduos com doença renal crônica submetidos à confecção FAV. A correlação significativa entre a realização prévia de hemodiálise prévia e certos parâmetros laboratoriais, reforça a importância da identificação precoce e do manejo adequado das comorbidades, a fim de aprimorar os desfechos clínicos e a qualidade de vida desses pacientes.

Palavras-chave: Doença renal crônica; Fístula arteriovenosa; Terapia renal substitutiva.

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INTRODUCTION

Chronic kidney disease (CKD) represents a significant public health concern globally, characterized by the gradual and irreversible deterioration of kidney function. According to the guidelines established by Kidney Disease: Improving Global Outcomes (KDIGO), CKD is defined by structural and/or functional renal abnormalities lasting longer than three months, by the glomerular filtration rate (GFR), and albuminuria[1].

It is important to highlight some susceptibility factors for CKD, such as genetic predisposition, Black race, maternal-fetal factors, older age, and male gender. However, other conditions may also be involved as risk factors, such as systemic arterial hypertension, diabetes mellitus, smoking, and more specific pathologies, such as polycystic kidney disease, autoimmune diseases, glomerular diseases, infections, obstructions, and tumors[2]. Most early-stage cases are asymptomatic, requiring attention from healthcare professionals, particularly in high-risk patients[3]. The treatment of CKD involves managing underlying diseases, such as diabetes and hypertension, but many individuals progress to the need for renal replacement therapy (RRT)[4]. Hemodialysis is the most commonly used RRT in Brazil[5], approximately 94.2%, performed through a venous access, which can be a central venous catheter or an arteriovenous fistula (AVF), preferred for its low complication rate and good durability. However, delayed diagnosis hinders the preparation of the AVF, increasing the premature use of the central venous catheter, with risks of infections, high costs, and a negative impact on quality of life[3].

Studies show that only 41% of patients start dialysis with a mature AVF, which increases the risk of complications, mortality, and hospitalization time[6-8]. Thus, this study aims to analyze the clinical and laboratory profile of CKD patients undergoing AVF creation.

Methods

Study design

A cross-sectional study was conducted using data from chronic kidney disease patients who underwent AVF creation at a public healthcare university hospital in Belo Horizonte, Minas Gerais. The research was assessed and approved by the local Ethics in Research Committee on June 15, 2023, with the Certificate of Ethical Approval Submission (CAAE): 69907423.6.0000.5134.

Sample

A total of 40 patients diagnosed with CKD and indicated for the creation of an AVF were included in the sample during the period from July to November 2023, who consented to participate in the study by signing the Informed Consent Form. Patients under 18 years of age and those who had a previous AVF failure were excluded. The sample was obtained by convenience, based on the sample size analysis of similar studies used in the references of this work and the estimated number of patients undergoing AVF creation at the university hospital where the study was conducted. Initially, 60 individuals were approached, from whom clinical and demographic data were collected. However, after surgery for AVF creation, 20 patients did not return for outpatient follow-up to assess the patency and maturation of the AVF, including Doppler examination.

Among the previous pathological conditions, active smokers were considered those who reported regular use of any form of tobacco in the past 12 months, and former smokers were those who had stopped using any form of smoking for at least 12 months before data collection. Alcohol consumption was defined as any regular alcohol intake, without measuring the quantity or substance. The presence of prior coronary artery disease was determined based on clinical records in medical charts of individuals diagnosed with significant coronary artery intervention, confirmed by imaging tests or clinical history of myocardial infarction or angina. The presence of heart failure was determined based on clinical history and pre-admission tests that indicated cardiac dysfunction, such as echocardiogram and BNP (B-type natriuretic peptide).

All these variables were collected based on information recorded in medical charts.

Instruments and Procedures

Data were collected through a systematized collection protocol developed by the researchers, which included sociodemographic and clinical variables, organized and tabulated in Microsoft® Office Excel.

Statistical analysis

Categorical variables were presented with their respective simple frequency values and percentages. Continuous variables were described using the median and interquartile range.

To check the normality of the study variables, the Shapiro-Wilk test was performed. For comparing paired sample data, the Wilcoxon signed-rank test was used. The Fisher's exact test was applied to assess associations in contingency tables. In addition, the Student's t-test was employed for comparisons of means, while the Wilcoxon signed-rank test or the Mann-Whitney test were used for comparison of medians. Finally, the Chi-square test was used to analyze associations between categorical variables, adopting a significance level of 5%. The R program version 3.2.1 was used for the analysis.

Results

A total of 40 individuals (25 men) with an average age of 66 ± 17 years were included. The main risk factors found were hypertension (90%), diabetes (57.5%), and dyslipidemia (25%). Regarding the type of AVF created: 55% were radiocephalic, 37.5% brachiocephalic, and 7.5% brachioaxillary, with the left upper limb being the most used for creation. Table 1 presents the characteristics of the sample.

Figure 1 shows the distribution of patients according to age group.

Table 1. Sample characteristics (N = 40).

Characteristics	GENDER	
	Female, N = 15[1]	**Male**, N = 25[1]
Previous Dialysis		
YES	3 (20%)	9 (36%)
Age	68 (55, 75)[#]	58 (34, 71)[#]
Type of AVF		
BRACHIO-AXILLARY	1 (6.7%)	2 (8.0%)
BRACHIOCEPHALIC	8 (53%)	7 (28%)
RADIOCEPHALIC	6 (40%)	16 (64%)

continue...

... continued Table 1

Characteristics	GENDER	
	Female, N = 15[1]	**Male**, N = 25[1]
Limb		
RUL	2 (13%)	8 (32%)
LUL	13 (87%)	17 (68%)
HTN		
YES	14 (93%)	22 (88%)
DM		
YES	9 (60%)	14 (56%)
DLP		
YES	5 (33%)	5 (20%)
Hypothyroidism		
YES	3 (20%)	3 (12%)
Smoking		
YES	2 (13%)	3 (12%)
Alcoholism		
YES	0 (0%)	6 (24%)
CAD		
YES	2 (13%)	1 (4.0%)
HF		
YES	1 (6.7%)	3 (12%)
Malignancy		
YES	3 (20%)	0 (0%)

[1]n (%); [#]median (interquartile range)

Abbreviations: AVF = Arteriovenous fistula; CAD = Coronary artery disease; DLP = Dyslipidemia; DM = Diabetes mellitus; HTN = Systemic hypertension; HF = Heart failure.

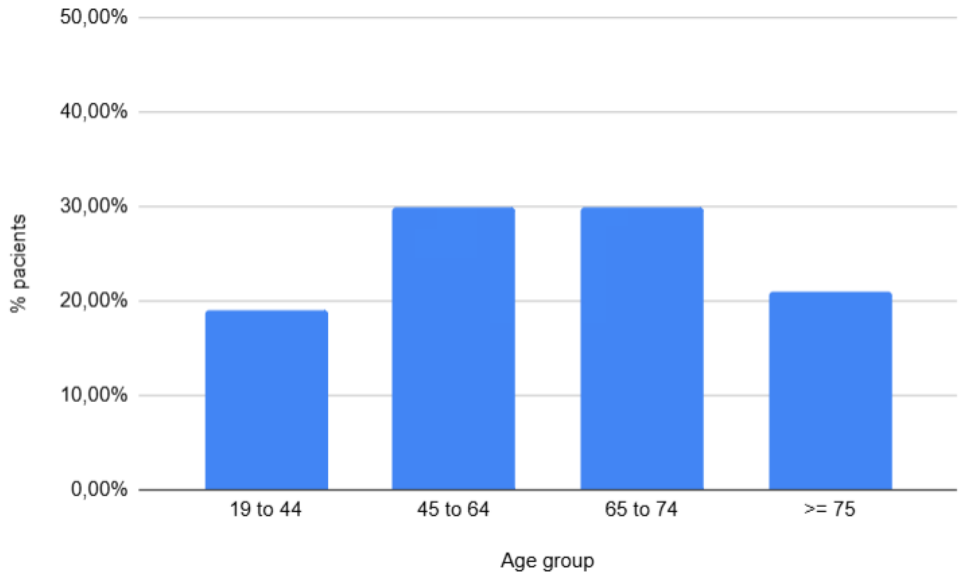

Figure 1. Distribution of patients according to age group.

Approximately 12 individuals underwent HD before the creation of the AVF. A statistically significant difference was found between the medians of the groups that had or had not undergone prior HD and the values of creatinine (p=0.030), hematocrit (p=0.041), and serum sodium (p=0.017).

Only 7 individuals experienced complications after surgery: 2 had maturation failure, 1 had thrombosis, 2 had infections, 2 had steal syndrome, and 2 had stenosis, with one of them presenting more than two concurrent complications.

Discussion

It is essential to outline the clinical and epidemiological profile of patients with chronic kidney disease who undergo arteriovenous fistula (AVF) creation for hemodialysis, to evaluate the quality of medical care provided, both at the outpatient and hospital levels. Knowledge of these variables in the analyzed population allows for the adoption of strategies that minimize the occurrence of undesirable complications, thus improving clinical outcomes and quality of life for these patients.

In 2022, the Brazilian Society of Nephrology (SBN) published the 2020 Brazilian Dialysis Census, performing a stratification of individuals undergoing Renal Replacement Therapy (RRT). It was found that the male sex constitutes most dialysis patients, approximately 58%[9], which aligns with the present study, where 62.5% of the sample are men. The prevalence of male patients is seen in other studies with dialysis patients from various centers across Brazil[10-12]. This distribution may indicate a higher tendency of men to suffer from chronic diseases such as diabetes and hypertension, as they tend to visit healthcare services less often, making them more vulnerable to progressing to chronic kidney disease (CKD) due to untreated underlying diseases, as evidenced in this and other epidemiological studies[13].

In the 2020 Census, the most prevalent age group was between 45 and 64 years, representing 42.5%, which contrasts with the findings of this study, where only 30% of the individuals were in this age group. An average age of 66 ± 17 years was observed, and 82.5% of individuals were older than 45 years. This data indicates that advanced age is a risk factor for CKD, and patients in this healthcare service are presenting later for AVF creation, either due to delays in referral and diagnosis or due to better outpatient control and treatment.

Regarding access for hemodialysis, only 12 (30%) individuals underwent hemodialysis using a temporary vascular access before AVF creation, even those already being followed by a nephrologist. According to the *National Kidney Foundation* guidelines, the definitive vascular access, whether a fistula or prosthesis, should be created 3 to 6 months before the first dialysis session[14]. However, this value is close to the finding in the 2020 Census, where 25% of hemodialysis patients used a central venous catheter. These findings reflect a significant delay in the proper preparation of these patients for hemodialysis, suggesting the need for improvements in the coordination of pre-dialysis care. Additionally, this delay may lead to further complications, such as an increased risk of infections and frequent hospitalizations, highlighting the importance of more efficient pre-operative planning.

Another aspect analyzed in this study was the presence of comorbidities in the patients, given that chronic kidney disease is linked to numerous comorbidities. According to the 2020 Census (SBN), hypertension affects 32% of CKD patients undergoing dialysis, being the leading cause of CKD in Brazil, followed by diabetes mellitus (31%) and chronic glomerulonephritis (9%). In the present study, 90% of patients had hypertension, 57% had diabetes, and 10% had heart disease. The data found for the prevalence of hypertension align with the study by Cardelino et al.

Table 2. Laboratory tests of participants, with or without previous RRT.

	Previous RRT		
Laboratory test	**NO** N = 28[#]	**YES** N = 12[#]	p[2]
Hemoglobin (g/dL)	10.65 (9.25, 11.75)	9.50 (7.90, 11.35)	0.3
Hematocrit (%)	32.5 (26.1, 36.6)	27.3 (23.1, 32.0)	**0.041**
Leukocytes (cells/µL)	7.580 (6,690, 9,090)	7.590 (5.675, 11.815)	>0.9
Platelets (mL)	190.000 (160.000, 250.000)	190.500 (141.500, 251.000)	0.6
Creatinine (mg/dl)	5.52 (3.39, 7.10)	7.29 (5.45, 8.48)	**0.030**
Urea (mg/dl)	130 (92, 160)	117 (98, 141)	0.5
ClCr CKD-EPI (mL/min)	11.0 (7.0, 16.0)	8.0 (6.5, 12.0)	0.10
INR	1.05 (1.00, 1.14)	1.04 (1.00, 1.24)	>0.9
Serum Sodium (mEq/L)	137.5 (136.0, 141.0)	135.0 (131.5, 138.0)	**0.017**
Serum Potassium (mEq/L)	4.50 (3.85, 5.05)	4.55 (4.30, 5.05)	0.6

[#]median (interquartile range)

Abbreviations: ClCr = Creatinine clearance; INR = Prothrombin time.

(2023)[15], conducted in the metropolitan region of São Paulo, Brazil.

Moreover, the progression of CKD is associated with a higher risk of cardiovascular diseases (CVD). Patients with CKD Stage 2 (eGFR = 60-89 ml/min) have a relative risk of death from CVD (5-year risk) of 19.5, while in Stage 4 (eGFR 15-29 ml/min), this risk rises to 45.7. Therefore, it is evident that early diagnosis, as well as optimized treatment of CKD, delays disease progression and its impact on patient survival. This phenomenon can be explained by a series of factors, including endothelial dysfunction, chronic inflammation, changes in lipid and mineral metabolism, as well as volume overload and hypertension, all of which are common in advanced CKD[17]. In the present study, about 4 patients had heart failure.

It is known that in diabetic patients, metabolic changes related to this comorbidity induce a pro-thrombotic state, vascular endothelial damage, deregulation of growth factors, and increased deposition of extracellular matrix. These elements, combined with inflammatory processes, are crucial determinants in the initial onset of stenosis and thrombosis in AVFs[18]. The results of a retrospective study involving 31 patients with AVFs indicated that diabetes is a significant negative predictor for venous remodeling, as also identified in this study. Therefore, strict control of diabetes and meticulous pre-operative planning are essential to improve outcomes in diabetic patients who require an AVF for hemodialysis[19].

In patients undergoing AVF creation, distal segments should be prioritized over proximal ones. The recommended sequence is: radio-cephalic, brachio-cephalic, brachio-basilic superficialized, and graft with prosthesis. This prioritization is recommended because AVFs created in distal segments have a higher probability of maturation and immediate success due to the better quality and caliber of arteries and veins in these areas; they have greater durability over time, requiring fewer revisions or corrective procedures compared to proximal AVFs; the incidence of complications such as stenosis, thrombosis, and infections is generally lower in distal AVFs, contributing to greater safety and less need for additional interventions; and distal locations facilitate access during hemodialysis sessions, providing greater comfort for the patient[20]. In this study, 55% of the AVFs created were radio-cephalic, 37.5% were brachio-cephalic, and 7.5% were brachio-axillary, with the left upper limb used in 75% of the cases. Thus, it is evident that the results of this study align with those found in the literature, reiterating the importance of careful selection of the AVF creation site to optimize clinical outcomes for patients undergoing hemodialysis.

Approximately 9 (22.5%) complications were observed in the AVFs created. Among the possibilities, the most common were: maturation failure, thrombosis, infection, stenosis, and steal syndrome. It is worth noting that compared to the results of other studies involving complications in AVF creation, this study presented a high rate of complications. However, it was observed that in this study, there was a significant correlation between the high number of complications and the clinical state of the patients before AVF creation, especially concerning changes in laboratory values of creatinine, hematocrit, and serum sodium, as well as poor control of comorbidities, particularly hypertension and diabetes. In this regard, a study published in the Brazilian Journal of Nephrology, conducted at a Brazilian outpatient intervention nephrology center, reported a complication rate of 13.67%, with only one patient requiring hospitalization and four accesses lost due to the presence of hematomas and/or thrombosis[21].

This study has some limitations that should be considered when interpreting the results. First, it is a cross-sectional analysis at a single center, which limits the generalization of the findings to other situations and contexts. Additionally, the relatively small sample size may restrict the identification of more robust associations between variations. The reliance on medical records may have introduced some information bias due to incomplete or inconsistent data. Finally, the lack of longitudinal follow-up prevents the evaluation of the impact of clinical and laboratory characteristics on the long-term outcomes of patients who undergo AVF creation. Studies with larger samples and prospective designs may contribute to a more comprehensive and detailed understanding of this topic.

Conclusion

There is a high prevalence of comorbidities such as diabetes and hypertension among individuals with CKD undergoing AVF creation. These conditions are frequently associated with the progression of kidney disease and the need for RRT, such as hemodialysis. The significant correlation between prior RRT and certain laboratory parameters, such as creatinine, hematocrit, and serum sodium levels, highlights the importance of continuous surveillance and early management of these clinical conditions.

Furthermore, it is crucial to consider that the success of the arteriovenous fistula depends not only on the surgical technique but also on the overall health of the patient and effective management of comorbidities. Early intervention to control modifiable risk factors, such as hypertension and diabetes, can not only improve AVF outcomes but, more importantly, reduce the risk of postoperative complications and enhance the quality of life for patients throughout their dialysis treatment.

Therefore, integrated strategies that include regular monitoring, patient education, and multidisciplinary teamwork are essential to optimize clinical outcomes and ensure the sustainability of arteriovenous fistulas as vascular access for hemodialysis.

Author's contribution

We describe contributions to the papers using the taxonomy (CRediT) provided above: *Conceptualization, Investigation, Methodology, Visualization & Writing – review*

& editing: AM; ALS; PD; FP. *Project administration, Supervision & Writing – original draft*: AM; ALS. *Validation & Software*: PD; FP. *Resources & Funding acquisition*: AM; ALS. *Data curation & Formal Analysis*: PD; FP.

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