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RESEARCH

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USE OF PHYSICAL EXAMINATION IN THE EVALUATION OF THE FUNCTIONALITY OF ARTERIOVENOSES FOR HEMODIALYSIS

Utilização do exame físico na avaliação da funcionalidade das fístulas arteriovenosas para hemodiálise

Utilización del examen físico en la evaluación de la funcionalidad de las fístulas arteriendas para hemodiálisis

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ABSTRACT

Objective: evaluate by physical examination changes present in the arteriovenous fistula during the maturation period and to propose a protocol of postoperative evaluation. **Materials and methods:** patients submitted to the construction of the access were interviewed and two physical exams were performed: the first between 24 and 48 hours after surgery and the second on the 15th postoperative day. **Results:** a total of 20 arteriovenous fistulas were evaluated, with predominance of males and mean age of 51.8 years. Hypertension was the most prevalent comorbidity (94.1%), followed by diabetes (47%). The Body Mass Index was in the range of normality in the majority (64.7%) and 58.8% were already in dialysis, 90% with a temporary catheter. Only six (30%) accesses had an early failure. **Conclusion:** the physical examination was useful in assessing the functionality of access and it is suggested that the protocol elaborated can be validated and used in the practice.
Descriptors: Arteriovenous Fistula; Physical Examination; Nursing Care.

RESUMO

Objetivo: avaliar por meio do exame físico alterações presentes na fístula arteriovenosa durante o período de maturação e propor um protocolo de avaliação pós-operatória. **Materiais e métodos:** foram entrevistados pacientes submetidos à construção do acesso e realizados dois exames físicos: o primeiro entre 24 a 48 horas após a cirurgia e o segundo no 15º dia do pós-operatório. **Resultados:** 20 fístulas arteriovenosas foram avaliadas, observando-se um predomínio do sexo masculino e idade média de 51,8 anos. A hipertensão

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foi a comorbidade mais prevalente (94,1%), seguida da diabetes (47%). O Índice de Massa Corporal mostrou-se na faixa da normalidade na maioria (64,7%) e 58,8% já encontrava-se em tratamento dialítico, 90% com cateter de curta permanência. Em apenas seis (30%) acessos foi constatada falha precoce. **Conclusão:** o exame físico mostrou-se útil na avaliação da funcionalidade do acesso e sugere-se que o protocolo elaborado possa ser validado e utilizado na prática do serviço.

Descritores: Fístula Arteriovenosa; Exame Físico; Cuidados de Enfermagem.

RESUMEN

Objetivo: evaluar por medio del examen físico alteraciones presentes en la fístula arteriovenosa durante el período de maduración y proponer un protocolo de evaluación. **Materiales y métodos:** fueron entrevistados pacientes sometidos a la construcción del acceso y realizados dos exámenes: el primero entre 24 a 48 horas y el segundo en el 15º día del postoperatorio. **Resultados:** se evaluaron 20 fístulas, observándose un predominio del sexo masculino y edad media de 51,8 años. La hipertensión fue la comorbilidad más prevalente (94,1%), seguida de la diabetes (47%). El índice de masa corporal se mostró en el rango de la normalidad en la mayoría (64,7%) y 58,8% se encontraba en tratamiento dialítico, 90% con cateter temporario. En sólo seis accesos (30%) se constató fracaso. **Conclusión:** el examen físico se mostró útil en la evaluación y se sugiere que el protocolo elaborado pueda ser validado y utilizado en la práctica del servicio.

Descriptores: Fístula Arteriovenosa; Examen Físico; Atención de Enfermería.

INTRODUCTION

Chronic kidney disease (CKD) is characterized by the progressive, irreversible kidney injury and loss of its function, which is affecting an increasing number of people mainly due to increased number of elderly people and morbidity rates associated with kidney changes, such as diabetes mellitus (DM) and systemic arterial hypertension (SAH)[1].

Kidney function may be represented by the glomerular filtration rate, which decreases with declining kidney function in patients with CKD and may reach values below 15 mL/min/1.73 m². This indicates the need for kidney replacement therapy (hemodialysis, peritoneal dialysis or kidney transplantation).[2,3]

According to the 2015 census data from the Brazilian Society of Nephrology, the number of patients on dialysis has been increasing over the years: it was 111,303 in 2015, 112,004 in 2014, 100,397 in 2013, 97,586 in 2012, 91,314 in 2011, and 65,121 in 2005. It was estimated that the number of patients on dialysis was 36,571 in 2015. Among the patients on chronic dialysis, 92.8% were on hemodialysis, 7.1% on peritoneal dialysis, and 28,866 patients were listed for transplantation. Regarding the type of vascular access, the percentage of patients using a central venous catheter was 9.7% for the short-term ones and 9.2% for the long-term ones; the percentage of patients with a vascular graft (prosthesis) was 4.1%. Arteriovenous fistula (AVF) was the preferred type of vascular access (77%).[4]

Once on hemodialysis, the patient needs vascular access that allows the connection of the patient's circulation to the external hemodialysis circuit.[5] Patients with end-stage renal disease undergoing hemodialysis spend money mainly on vascular accesses. Vascular access dysfunction represents approximately 20 to 25% of the causes of hospitalization in patients on hemodialysis.[6]

AVF is considered the gold standard for hemodialysis access. It is permanent access with a low number of complications when compared to central venous catheters, which increase the mortality rate by 50% and may deteriorate the patients' venous system (central stenosis, thrombosis), making it difficult to succeed in creating an AVF later. Nevertheless, AVF is also the most challenging access in the period preceding its use, when its maturation must be evaluated, which should be sufficient for its use in repeated punctures.[5,7]

The mean time to maturation of an AVF is variable, and usually takes approximately four to six weeks to heal and become dilated to support hemodialysis. The AVF puncture should not have been performed in less than one month, varying according to institutional norms decisions made by the interdisciplinary team.[7,8]

According to the 2006 National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF KDOQI)™, United States of America, a viable AVF should have the following characteristics: adequate blood flow to support hemodialysis (usually greater than 600 mL/min); a diameter greater than 0.6 cm, with an accessible puncture site and visible margins that allow repetitive puncture; and a depth of approximately 0.6 cm (ideally between 0.5 and 1.0 cm) from the skin surface.[9]

Several factors can influence the AVF maturation, such as patients' characteristics (advanced age, gender, diabetes, smoking, peripheral vascular disease, hypotension, and obesity); factors related to the preoperative period (early referral to health services for vascular treatment, use of Doppler ultrasonography for mapping of veins and arteries), intraoperative period (type of anastomosis, blood flow measurement), and postoperative period (time of the first puncture, puncture technique); anatomical factors (diameter of each vein and artery, presence of atherosclerosis, distensibility of the vein); and use of adjuvant medications (antiplatelet drugs and heparin).[10]

Early identification of problems affecting AVF patency may contribute to increasing its success, allowing revision of the surgical site and endovascular correction using percutaneous and surgical techniques.[5,10,11] In clinical practice, several criteria allow checking AVF maturation, including physical examination (PE) and Doppler flowmetry-ultrasonography (DUS). PE should be performed in order to assess the presence of a visible path, fremitus with good intensity and easy puncture as well as recognize problems such as stenosis, collateral branches, and arterial system problems. During the DUS, the diameter of the conduit should be greater than 4 mm and the flow greater than 400 mL/min.[5]

AVF systematic examination has been successfully employed to detect access dysfunctions and identify complications. The examination is easily performed through inspection, palpation, and auscultation of the AVF with a

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high level of accuracy. It is capable of detecting most cases of stenosis.[6,12,13]

Nurses have an important role in monitoring AVF functionality and maintaining access quality. During the PE, it is intended that they evaluate the limb before and after constructing the access. PE before construction of the AVF aims to identify what limb has the best conditions for such construction, while the evaluation after the construction of AVF aims to detect complications or situations that may compromise its development and maintenance, such as infection, venous stenosis, presence of collateral veins, aneurysms, theft syndrome, and venous hypertension.[14,15]

CAMPOS et al.[12] were pioneers in evaluating PE's accuracy in detecting AVF stenosis. PE has proven to be as effective as DUS in detecting stenosis. A protocol including PE, which should be performed monthly by a trained professional, is recommended. QUIRINO et al.[16] demonstrated the importance of implementing the safe surgery protocol for constructing AVFs. Because the nursing team and vascular surgeon followed up the patients undergoing surgery for the construction of AVFs, there was a significant improvement in postoperative care.

Considering the aforementioned, this study aimed at using PE to assess the functionality of AVF during the maturation period and propose a postoperative evaluation protocol including this method.

METHODS

This longitudinal study with a quantitative approach took place from March to September 2016 with patients with CKD referred by the Nephrology Service of *Hospital Barão de Lucena*. The patients needed an AVF for hemodialysis. Furthermore, a protocol for postoperative evaluation of the arteriovenous access was created, which can be seen in the Supplementary Material.

Male and female patients with CKD, aged over 18 years old, and those who underwent surgery for the construction of an AVF were included in the study. Patients who underwent a procedure for constructing or repairing prostheses and those with low consciousness levels that made participation in the research impossible were excluded.

Data collection was performed through semi-structured interviews based on a collection instrument previously reported in the literature.[17] This instrument was used to gather data about the patient and the procedure. Then, patients underwent PE involving inspection, palpation, and auscultation of AVFs as recommended by SOUSA.[18] The PE consisted of two stages. The first stage was performed during the first change of dressing (between 24 to 48 hours after surgery). The second stage was performed on the 15th postoperative day. During the inspection, the aspect of the operative wound was evaluated to find complication signs, vein size, and collateral veins. Palpation was employed to assess pulse strength and the presence of fremitus. Finally, auscultation was employed to assess the presence and characteristics of a heart murmur. Abnormal events occurring during PE were reported to the nephrologist and recorded on the collection instrument.

The Statistical Package for the Social Sciences (SPSS) 13.0 for Windows and Excel 2010 were used for data analysis. Results are presented tables with absolute and relative frequencies. The numerical variables were represented by measures of central tendency and dispersion. To verify the existence of an association between the categorical variables, we used the Chi-Square Test and Fisher's Exact Test. All tests were applied with a significance level of 5% (p-value = 0.05).

The study was approved by the Research Ethics Committee of the *Universidade Federal de Pernambuco* under protocol 52472416.5.0000.5208. Before being interviewed, the patients read and signed an informed consent document, as required by the Resolution No. 466/12.

RESULTS

Twenty AVFs were evaluated. The final sample was composed of 17 patients, of which one underwent three surgeries for AVFs and another underwent two surgeries due to failures in the previous procedures. The patients' identification data and clinical aspects are presented in **Table 1**.

Table 1 - Identification data and clinical characteristics of patients who underwent surgery for AVF.

Variables	N	%
Gender		
Male	10	58.8
Female	7	41.2
BMI		
18,5 |- 25,0	11	64.7
25,0 |- 30,0	3	17.6
≥ 30,0	3	17.6
Comorbidities and risk factors		
SAH	16	94.1
DM	8	47.0
Overweight/Obesity	6	35.2
Smoking	2	11.7
Heart Disease	2	10.0
PVD	1	5.0
CKD on hemodialysis		
Yes	10	58.8
No	7	41.2
Access in use		
Short-term catheter	9	90.0
Long-term catheter	1	10.0
Vascular prosthesis	0	0.0
AVF	0	0.0

Variables	N	%
Previous accesses		
Short-term catheter	10	58.8
AVF	7	41.1
Long-term catheter	2	11.7
Vascular prosthesis	0	0.0
	Average ± SD	**Minimum - Maximum**
Age	51.80 ± 13.74	28.00 - 82.00
Weight	69.85 ± 16.37	42.00 - 109.00
Height	1.66 ± 0.07	1.49 - 1.74
BMI	25.26 ± 5.29	18.73 - 39.08
Hemodialysis time	9.32 ± 8.06	0.50 - 24.00

AVF: arteriovenous fistula; BMI: body mass index; DM: diabetes mellitus; SAH: systemic arterial hypertension; PVD: peripheral vascular disease; CKD: chronic kidney disease; SD: standard deviation.

There was a predominance of males aged from 28 to 82 years old, with an average of 51.8 (± 13.74) years old. SAH was the most prevalent disease, followed by DM (47%). Overweight/obesity was found in a small number of patients (35.2%). More than half of the patients (58.8%) were already on dialysis. Considering these, all had a central venous catheter as vascular access, 9 (90%) had a short-term catheter and only one had a long-term catheter.

Table 2 presents the collected data about the AVF surgeries performed. Most of the AVFs were proximal (65%): 11 were brachiocephalic and 2 brachiobasilic. Most patients (85%) received guidance on access self-care.

Table 2 - AVF surgery data.

Variables	n	%
Type of AVF		
Radiocephalic	7	35.0
Brachiocephalic	11	55.0
Brachiobasilic	2	10.0
Guidance on self-care		
Yes	17	85.0
No	3	15.0

Table 3 shows the findings regarding the evaluation of the AVF through PE. There was a statistically significant difference only between the variables "bleeding" and "edema".

Table 3 - Assessment of the AVF through PE.

	Evaluations		
Variables	**1st evaluation n (%)**	**2nd evaluation n (%)**	**p-value**
AVF in good condition			
Yes	20 (100.0)	18 (90.0)	0.487 *
No	0 (0.0)	2 (10.0)	
Hematoma			
Yes	2 (10.0)	1 (5.0)	1.000 *
No	18 (90.0)	19 (95.0)	
Bleeding			
Yes	10 (50.0)	1 (5.0)	**0.001 ** **
No	10 (50.0)	19 (95.0)	
Inflammation			
Yes	4 (20.0)	3 (15.0)	1.000 *
No	16 (80.0)	17 (85.0)	
Edema			
Yes	10 (50.0)	4 (20.0)	**0.047 ** **
No	10 (50.0)	16 (80.0)	
Peripheral cyanosis			
Yes	0 (0.0)	0 (0.0)	---
No	20 (100.0)	20 (100.0)	
Infecction			
Yes	0 (0.0)	2 (10.0)	0.487 *
No	20 (100.0)	18 (90.0)	
Collateral veins			
Yes	0 (0.0)	0 (0.0)	---
No	20 (100.0)	20 (100.0)	
Pulse			
Normal	13 (65.0)	12 (60.0)	1.000 *
Decreased	5 (25.0)	5 (25.0)	
Absent	2 (10.0)	3 (15.0)	
Fremitus			
Normal	12 (60.0)	12 (60.0)	0.612 *
Decreaced	6 (30.0)	4 (20.0)	
Absent	2 (10.0)	4 (20.0)	
Auscultation			
Continuous heart murmur	15 (75.0)	14 (70.0)	0.764 *
Discontinuous heart murmur	2 (10.0)	1 (5.0)	
Absent	3 (15.0)	5 (25.0)	

(*) Fisher's exact test; (**) Chi-square test.

The changes found during PE (weak or absent pulse, negative increase-testing, hyper-pulsatile AVF, absent fremitus, or discontinuous or absent heart murmur) led to conclude that 6 AVFs were not working at the end of the second evaluation.

The patients' clinical and demographic characteristics grouped by type of AVF (functioning and non-functioning) and obtained through PE are found in **Table 4**.

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Table 4 - Correlation between the patients' clinical and demographic variables grouped by type of AVF.

Variables	Total n (%)	Functioning AVF n (%)	Non-functioning AVF n (%)	p-value
Gender				
Male	13 (65.0)	5 (25.0)	2 (10.0)	1.000*
Female	7 (35.0)	9 (45.0)	4 (20.0)	
Idade				
20-35	2 (10.0)	1 (5.0)	1 (5.0)	0.417**
36-50	7 (35.0)	4 (20.0)	3 (15.0)	
51-65	9 (45.0)	7 (35.0)	2 (10.0)	
> 65	2 (10.0)	2 (10.0)	0 (0.0)	
DM				
Yes	8 (40.0)	7 (35.0)	1 (5.0)	0.140**
No	12 (60.0)	7 (35.0)	5 (25.0)	
Overweight/ Obesity				
Yes	4 (20.0)	3 (15.0)	1 (5.0)	1.000*
No	16 (80.0)	11 (55.0)	5 (25.0)	
Smoking				
Yes	2 (10.0)	1 (5.0)	1 (5.0)	0.521
No	18 (90.0)	13 (65.0)	5 (25.0)	
Prior CVC				
Yes	11 (55.0)	8 (40.0)	3 (15.0)	1.000*
No	9 (45.0)	6 (30.0)	3 (15.0)	

DM: diabetes mellitus; CVC: central venous catheter; (*) Fisher's exact test; (**) Chi-square test.

DISCUSSION

The analysis of patients' profiles showed a higher percentage of men aged from 28 to 82 years old, with an average of 51.80 (± 13.74) years old, then evidencing significant variability. Concerning the clinical data, most of the patients' BMIs were in the normal range. Moreover, SAH was the predominant disease among the patients, followed by DM. These findings corroborate the 2015 census data from the Brazilian Society of Nephrology, which provided information about patients on hemodialysis.[4] The presence of octogenarian patients undergoing surgery for autologous fistula was highlighted. All of them presented adequate access patency, which is in line with other studies, which reported that the access patency in octogenarian and younger patients may be similar. Age alone should not impede the construction of AVFs in elderly patients.[19,20]

According to the study results, 41.2% of the patients were receiving conservative treatment. Among those on hemodialysis, the majority had a short-term catheter and only seven (41.1%) already had a functioning AVF, which demonstrates that the input plan for patients with CKD on hemodialysis has not been carried out satisfactorily. One of the main reasons is the late diagnosis of end-stage renal disease due to underdiagnosis, reinforcing the importance of primary and secondary care programs for identifying risk groups for CKD and referring people in these groups to nephrologists early and immediately. Consequently, the number of patients needing a short-term catheter is reduced and they had a better prognosis compared to those on emergency dialysis.[21,22]

The AVFs were grouped by location. Seven AVFs (35%) were distal radiocephalic, and 13 (65%) were proximal. Considering these, 11 (55%) were brachiocephalic and two (10%) were brachiobasilic. According to current practice guidelines, radiocephalic AVF is the first access type to be chosen, followed by brachiocephalic and brachiobasilic AVF. The reason is that creating the most distal access contributes to the preservation of proximal veins that may be available for a future AVF surgery in case of loss of the previous one. In addition, it is relatively simple to create this access with a low incidence of complications.[9] However, it is necessary to take into consideration special groups of patients such as the elderly with comorbidities and risk factors such as DM, hypertension, peripheral vascular disease, and amputations. Elderly patients may benefit from the choice of proximal AVFs as the first access option, abandoning the rigid and historical tendency to create distal AVFs first in all cases.[23]

Concerning the important guidelines on access self-care, only three patients reported not receiving them. Self-care behaviors allow the development of skills, making patients with CKD able to identify and avoid situations that lead to AVF dysfunction.[15] During AVF maturation, guidance aimed at increasing AVF durability should be provided. Moreover, it should include the following actions: keeping the limb with the access elevated during the first days to favor return circulation and avoid the formation of edema, avoiding adjusted circumferential dressings, evaluating blood flow daily, and performing manual compression exercises to promote AVF maturation.[8,24,25]

Only in six (30%) AVFs failed early. According to the literature, some factors affect the maturation and consequent functionality of AVFs. It is possible to verify that individual factors, such as DM, female gender, age, smoking, BMI, and prior use of central venous catheters, affect access patency.[5,10,20,26] Here, no statistically significant difference was found between these variables and functionality of the permanent access, which may be due to the small sample size.

Abnormal conditions were found during PE. Inflammation, infection, hematoma, and edema were the ones found specifically during inspection; reduction or absence of pulse rate, and fremitus were found during palpation; and discontinuous or absent heart murmur were found during auscultation. No peripheral cyanosis and collateral veins were observed during the study. As previously mentioned, the comparison between the two

evaluations showed that only bleeding and the presence of edema had a statistically significant difference. Bleeding is not uncommon in operative wounds, but it requires attention because it can become more intense, in addition to being one of the most frequent AVF complications. Bleeding can lead to irreversible loss of access.[27] Edema can be expected to occur within the first days of the postoperative period, but it tends to regress spontaneously. Developing edema is a warning sign of suspected venous hypertension, a complication that usually develops due to the existence of central venous occlusion on the same side where the AVF was created. The occlusion or stenosis may be clinically asymptomatic before the creation of the access, especially due to an increased flow caused by the presence of an AVF. The pressure in the venous segment interferes with the venous drainage of the hand, causing thumb or hand pain and the formation of a bulky and painful hand edema.[15]

CONCLUSIONS

Herein, it is concluded that PE can be useful to evaluate AVF functionality by identifying early problems that affect access viability. It was found that 70% of the AVFs presented early success in terms of functionality since the need for increasingly creating this type of access was positively highlighted. The patients were referred to the vascular team before undergoing hemodialysis, which avoided the need for inserting short-term catheters and consequently complications related to them.

Several risk factors affected the success of an AVF. The importance of considering the factors that may affect the functionality of an AVF should be highlighted, finding ways to prevent possible complications.

By using this study results and information from the literature, it was possible to elaborate a protocol aimed at standardizing PE that can be used in nursing practice. Suggesting that this protocol should be implemented as an important contribution as new types of AVF emerge, facilitating the accurate evaluation of access maturation in combination with the DUS.

The sample size could have hindered the congruence of the analysis. Nonetheless, this study helped to reflect on the importance of recognizing the aspects involved in the success of an AVF, allowing reflection on the importance of correctly assessing vascular accesses.

Bearing in mind the aforesaid, it is hoped that the suggested protocol can be validated and used so that nursing care in nephrology can develop. Moreover, the quality of nursing care for patients with AVF can increase, allowing early diagnosis of changes in the functioning of AVFs so that they can last longer. These represent benefits for patients, whose access is vital for keeping them alive, and the health system because of the reduced costs of complications relating to hemodialysis access.

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Use of physical examination in the evaluation of the functionality...

SUPPLEMENTARY MATERIAL

Follow-up of post-operative patients with arteriovenous fistula (AVF)
Patient's name:_____ Age:____
Did you receive guidance on post-operative AVF self-care? ( )Yes ( )No
Date of surgery ___/____/____ Location_____: _____
Type of surgery: ( )Construction ( )Repair
Type of AVF:
( )Radiocephalic ( )Right ( )Left ( )Brachiocephalic ( )Right ( )Left
( )Brachiobasilic ( )Right ( )Left ( )Other _____

1st evaluation (between 24 and 48 h after surgery)	2nd evaluation (after 15 days)	3rd evaluation (after 30 days)
Date:__/__/__	Date:__/__/__	Date:__/__/__
1)Inspection	1)Inspection	1)Inspection
Complications ( ) No ( )Yes	Complications ( ) No ( )Yes	Complications ( ) No ( )Yes
( )Flogistic signs ( ) Secretion	( )Flogistic signs ( ) Secretion	( )Flogistic signs ( )Secretion
( )Bleeding ( )Hematoma	( )Bleeding ( )Hematoma	( )Bleeding ( )Hematoma
( )Edema ( )Visible collateral veins	( )Edema ( )Visible collateral veins	( )Edema ( )Visible collateral veins
( )Peripheral cyanosis	( )Peripheral cyanosis	( )Peripheral cyanosis
( )Hematoma	( )Hematoma	( )Hematoma
Others:	Others:	Others:_____
2) Palpation	2) Palpation	2) Palpation
Pulse: ( )Present ( )Absent Fremitus: ( ) Present ( )Absent	Pulse: ( )Present ( )Absent Fremitus: ( ) Present ( )Absent	Pulse: ( )Present ( )Absent Fremitus: ( ) Present ( )Absent
3) Auscultation	3) Auscultation	3) Auscultation
Heart murmur: ( )Present ( )Absent	Heart murmur: ( )Present ( )Absent	Heart murmur: ( )Present ( )Absent
Interventions: ( )No ( )Yes What?_	Interventions: ( )No ( )Yes	Interventions: ( )No ( )Yes What?_____
Comments:_____	What?_	Comments:_____
Signature:	Comments:_: _____	Signature:
	Signature:	

Date of first puncture: _____/_____/_____
Complications ( )No ( )Yes Comments:

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