

Original Paper

Predictive Factors for Native AVF Complications in Dialysis Patients - A Prospective Study in a Public Hemodialysis Center

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REZUMAT

Factori de predicție pentru complicațiile fistulei arteriovenoase native la pacienții dializați – studiu prospectiv într-un Centru public de hemodializă

Introducere: Progresele notabile în dezvoltarea tehnicii de supleere renală au permis creșterea calității și speranței de viață pentru pacienții dializați, impunând necesitatea unui abord vascular capabil de a susține această formă de tratament pe o perioadă cât mai lungă de timp.

Scopul studiului: Evaluarea prevalenței complicațiilor asociate fistulei arteriovenoase (FAV), dar și a factorilor predispozanți incriminați în apariția acestora, la pacienții dializați cronic internați pentru afecțiuni nelegate de calea de abord vascular.

Material și metodă: În acest studiu observațional, prospectiv și longitudinal, cu durata de 3 ani, am inclus toți pacienții dializați cronic pe fistulă arteriovenoasă nativă internați în Spitalul nostru și care au efectuat minimum o ședință de hemodializă în Clinica Nefrologie și Dializă. Am consemnat pentru fiecare pacient informațiile demografice și clinice cunoscute a influența funcționalitatea FAV și am efectuat examinări clinice și imagistice ale abordului vascular, înregistrând fiecare complicație specifică FAV. S-au realizat corelații statistice între complicațiile observate și potențialii factori de risc consemnați.

Rezultate: Au fost evidențiate 134 complicații ale FAV (61,4%) la cei 218 pacienți incluși în studiu, internați pentru diferite motive nelegate de abordul vascular. Am consemnat 32 de aneurisme de fistulă (14,67%), 16 cazuri de sindrom de furt arterial (7,34%), 68 stenoze (31,19%), doar 3 tromboze parțiale, 11 bolnavi cu FAV cu debit crescut (5%) asociind ICC (insuficiență cardiacă congestivă) și 4 cazuri de hipertensiune venoasă. Principalii factorii predispozanți incriminați au fost: vârsta, debitele sanguine mari din dializă, fluxul crescut în FAV.

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Concluzii: Complicațiile silențioase ale FAV apar cu o frecvență îngrijorătoare; diagnosticarea lor precoce impune perfecționarea protocoalelor de monitorizare periodică a accesului vascular. Dializa high-flux poate fi incriminată în creșterea ratei de apariție a complicațiilor FAV.

Cuvinte cheie: hemodializa, fistula arteriovenoasă nativă, complicații, factorii de risc

ABSTRACT

Introduction: The improvements in dialysis techniques determined increasing quality and lifetime of dialysis patients and the need for a reliable vascular access that allows the procedure for long periods of time.

Aims: To evaluate the prevalence of arteriovenous fistula (AVF) complications in hospitalized patients on maintenance dialysis admitted for other reasons than vascular access problems and to assess the impact of known predisposing factors for each complication.

Materials and methods: In this prospective longitudinal, hospital-based, observational study we enrolled 218 dialysis patients with native AVF as vascular access; all the maintenance dialysis patients admitted in the hospital in a 3 years interval were included. We noted all the demographic and clinical data known to interfere with AVF functionality and we performed clinical examination and imagistic tests for each patient to assess the fistula morphology and patency; every AVF complication was recorded. Statistical correlations were made between each complication found and the prevalence of potential predisposing factors.

Results: 134 AVF complications (61.4%) were found in a group of consecutive 218 patients hospitalized for various reasons unrelated to the vascular access. There were 32 aneurysmal AVF (14.67%), 16 steal syndromes (7.34%), 68 stenosis (31.19%), only 3 partial thrombosis, 11 high-flow FAV associated with heart failure (5%) and 4 venous hypertension cases. Main predisposing factors found were age, high dialysis blood flows, and high AVF flows (Qa).

Conclusions: Silent complications of AVF represent a serious problem emphasizing that the periodic assessment of the vascular access should be intensified and made with the utmost attention. High-flux dialysis may contribute to increase the rate of fistula complications.

Key words: hemodialysis, native arteriovenous fistula, complications, risk factors

INTRODUCTION

The prevalence of end stage renal disease (ESRD) is constantly increasing in worldwide population, as is the necessity of renal replacement therapy [1-3]. The improvements in dialysis techniques determined increasing quality and lifetime of dialysis patients and the need for a reliable vascular access that sustains the procedure for long periods of time. On the other hand, the progressive aging of dialyzed population and the emerging complications, as well as the rising prevalence of diabetes as a cause for chronic kidney disease (CKD), hampers the processes of obtaining and maintaining an adequate vascular access [1,4,5]. Since Brescia and Cimmino elaborated the first arteriovenous fistula (AVF) in 1966, this type of vascular access, with several variants, remains the most suitable way to ensure the

blood flow necessary for hemodialysis [1,4,5]. Far from ideal, native fistula is still considered the optimal vascular access due to the lowest rate of complications comparative to catheters and grafts [1,6,7]. That is why the AVF maintenance and early diagnosis and management of all its complications are important problems requiring multidisciplinary approach: nephrologist, medical imaging specialist, vascular surgeon [1,6,7].

We performed a three-year observational study in which we recorded and analyzed silent AVF complications found in all dialysis patients admitted, for any pathology, in "Saint John" Emergency Clinical Hospital Bucharest. The aim of our research was to determine the prevalence of each type of native vascular access complications in a heterogeneous lot of chronic dialysis patients and highlight the predisposing factors involved in their occurrence.

MATERIALS AND METHODS

We enrolled all the dialysis patients admitted in “Saint John” Emergency Clinical Hospital Bucharest during the study period – in the Departments of Nephrology and Dialysis, Surgery, Cardiology, Urology – who performed dialysis sessions in our Department of Nephrology and Dialysis (temporary transferred patients). The inclusion criteria were the presence of native arteriovenous fistula in a chronic patient who performed at least one dialysis session in our Center. For every patient we registered demographic data (age, gender), etiology of CKD, duration of dialysis, AVF age, body mass index (BMI), important comorbidities (diabetes mellitus, hypertension, heart failure, stroke, vascular disease), dialysis technique characteristics (ultrafiltration volumes for each session, blood flow); we performed for each patient echocardiography and duplex ultrasonography of the arteriovenous fistula, noting the blood flow and the morphological characteristics of the vascular access. Every known type of AVF complication was investigated, recorded and staged.

The data were collected by physical examination, consulting the admission chart and performing imagistic tests. Echocardiography were done by a certified cardiologist using a ALOKA ultrasonograph with a 2,5 MHz probe, in M and B-mode; duplex ultrasound was performed on a Mindrey Diagnostic Ultrasound System using the B-mode and the color Doppler with a 3 – 4,5 MHz probe and a 7,5 – 10 MHz probe.

We diagnosed significant fistula stenosis when the diameter of the vessel was obstructed more than 50%, with a AVF flow under 200 mL/min and high venous pressures noted in hemodialysis sessions protocols; obstruction of less than 50% and a peak systolic velocity over 400 cm/s diagnosed stenosis under the degree of significance [1,8,9]. Partial thrombosis diagnosis was established by the presence of alterations in vessel morphology and a modified resistivity index [10,11]. AVF aneurysm was diagnosed in the presence of a measured dilatation exceeding twice the diameter of the vein [8,9,11,12]. High-flow AVF were considered those accesses with a blood flow (Qa) over 2000 mL/min [13,14].

The study group included all the patients, with and without AVF complications; we analyzed the prevalence of each factor known to be involved in the occurrence of vascular access malfunctioning.

Correlations were made between the presence of each complication and each predisposing factor. We used odds ratio (OR) statistical method for these correlations.

RESULTS

We recorded a total of 218 patients, median age 54 ± 16.4 years, 114 (52.3%) men, originating from 11 dialysis centers all over the southern region of Romania. Their demographic and clinical characteristics are gathered in **Table 1**.

134 AVF complications (61.4% of all AVF) were noted in 107 patients (49% of all patients). The prevalence of these complications in the study group is: 32 aneurysmal AVF (14.67%), 16 steal syndromes (7.34%), 68 stenosis (31.19%), (and) only 3 partial thrombosis, 11 high-flow FAV associated with heart failure (5%) and 4 venous hypertension cases. In the group of complicated AVF the specific prevalence for each complication are as follows: 23.88% aneurysmal AVF, 11.94% steal syndromes, 50.74% vascular stenosis, 2.23% thrombosis, 8.20% high-flow AVF and 2.98% venous hypertension.

We studied the prevalence of each characteristic in the groups of patients diagnosed with each AVF complication and calculated OR for these characteristics. The limit of signification for OR was found to be 1.96 for the group.

Aneurysmal AVF was found to be correlated with: hypertensive nephropathy and chronic pyelonephritis as the underlying chronic kidney disease (OR 2.17 and 4.25), age between 50 – 65 years (OR 2.56), time on dialysis more than 5 years (OR 13.31), brachiocephalic type of fistula (OR 2.42), nutritional status – with the underweight group prevailing (OR 3.97), dialysis blood flow rate over 300 mL/min (OR 3.13) and AVF flow rate (Qa) over 1600 (OR 2.31, with a higher value of 8.35 in the group with high-flow AVF). There were no correlations with the underlying cardiac pathology or with the dialysis ultrafiltration volumes.

The arterial steal syndromes (several of them with low degrees of ischemic neuropathy) were correlated with: diabetes and atherosclerotic nephropathy as underlying kidney diseases (OR 3.12 and 6.43, respective), age over 65 years old (OR 2.16), dialysis duration between 5 – 10 years (OR 2.36), brachiocephalic type of fistula (OR 2.27), Qa over 2000 mL/min (strong correlation, OR 9.29), dialysis flow rates over 300 mL/min (OR 2.65), underweight and

Table 1. Demographic and clinical characteristics of the studied patients (no. of patients)

Underlying kidney disease						
DM	HT	CGN	CTN	PKD	IN	Miscellaneous
57	49	34	40	24	10	4
Comorbidities						
DM	HT	Stroke	LVF/HF	Dislipidemia	Liver disease	
62	173	15	26/12	46	15	
Dialysis duration						
< 3 months	3 months – 3 years		3 – 5 years		5 – 10 years	> 10 years
31	75		62		29	21
Nutritional status						
Obese	Normal weight		Underweight		Malnutrition	
31	155		28		4	
Dialysis blood flow						
< 250 mL/min	251 – 280 mL/min		281 – 300 mL/min		> 300 mL/min	
10	52		81		75	
Weight gain between dialysis sessions						
< 1000 mL	1000 – 2000 mL		2000 – 4000 mL		> 4000 mL	
20	26		134		38	
EF% value						
< 49%	50 – 60%		> 60%			
75	122		21			
AVF types						
Radiocephalic	Brachiocephalic		Brachio basilic		Brachio brachial	
56	112		42		8	

Legends: DM = diabetes mellitus; HT = hypertension; CGN = chronic glomerulopathies; CTN = chronic tubulointerstitial nephropathies; PKD = polycystic kidney diseases; IN = ischemic nephropathies; LVF = left ventricular failure; HF = heart failure; EF = ejection fraction; AVF = arteriovenous fistula

malnourished patients (OR 13.5), coronary disease (OR 8.39) and congestive heart failure (OR 2.36). There were no correlations with ultrafiltration volumes.

We found the AVF stenosis to be associated with: diabetes and ischemic nephropathy as underlying diseases (OR 2.63 and 9.87), age over 65 years (OR 2.39), time on dialysis over 10 years (OR 2.41), ischemic coronary disease and congestive heart failure as comorbidities (OR 3.18 and 5.11, respective), brachio basilic type of fistula (OR 3.18), small dialysis blood flows (OR 5.15 for values between 250 – 280 mL/min and OR 9.87 for flows under 250 mL/min), large ultrafiltration volumes (OR 3.01), poor nutritional status (OR 2.11).

High-flow AVF were correlated with: hypertensive nephrosclerosis and glomerulopathies as underlying renal diseases (OR 3.09 and 2.53), age 50 – 65 years (OR 3.66), dialysis duration over 5 years (OR 4.33), dialysis blood flow over 300 mL/min (OR

18.32), brachiocephalic type of AVF (OR 2.6) and large ultrafiltration volumes, over 4000 mL (OR 4.89).

We found only 3 partial vascular thrombosis of the AVF. This is a very low prevalence, in contrast with severe AVF thrombosis which is usually clinically significant and induces vascular access malfunctioning affecting the quality of dialysis and determining immediate referral to the vascular surgeon.

The venous hypertension found in 4 patients is a visible and easy to diagnose complication. It is unaesthetic but often without consequences, therefore it does not require surgical correction.

The association of the above mentioned complications with various predisposing factors are presented in the following charts (Figs. 1-6).

DISCUSSIONS

We conducted a prospective, longitudinal,

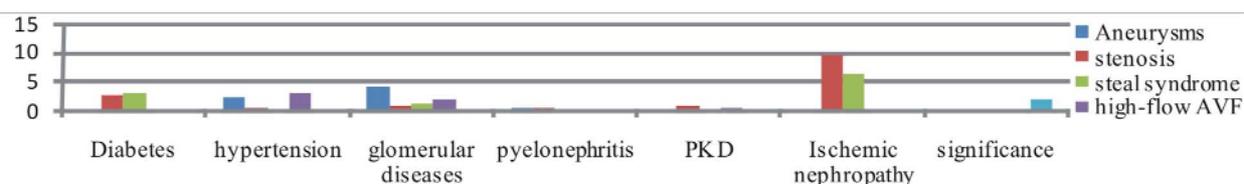


Figure 1. Correlations between AVF complications and the underlying kidney disease

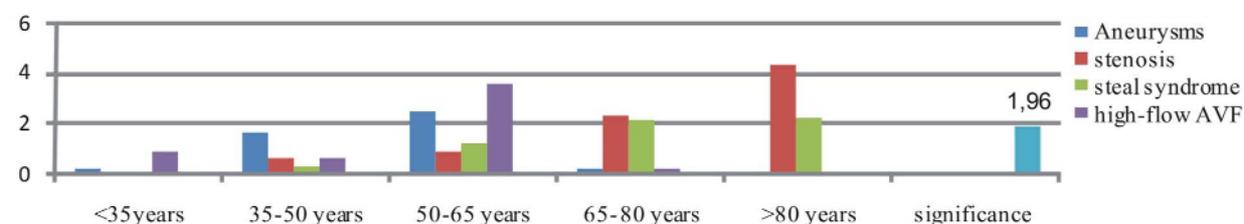


Figure 2. Correlations between age and AVF complications

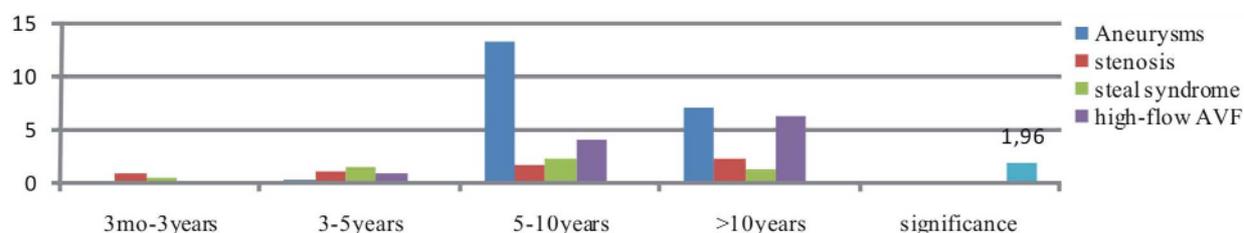


Figure 3. Correlations between AVF complications and duration of dialysis

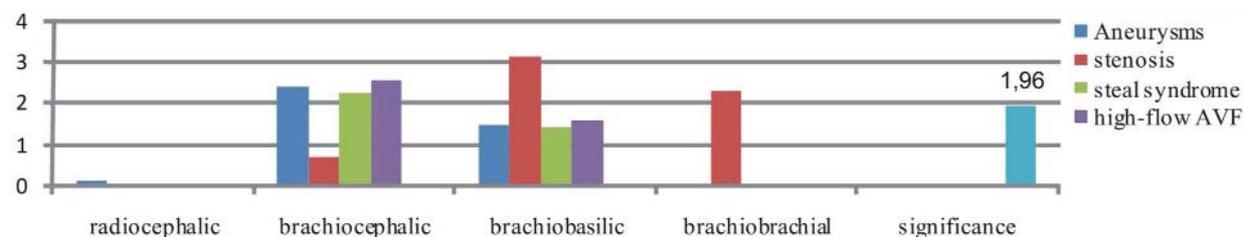


Figure 4. Correlations between AVF complications and fistula type

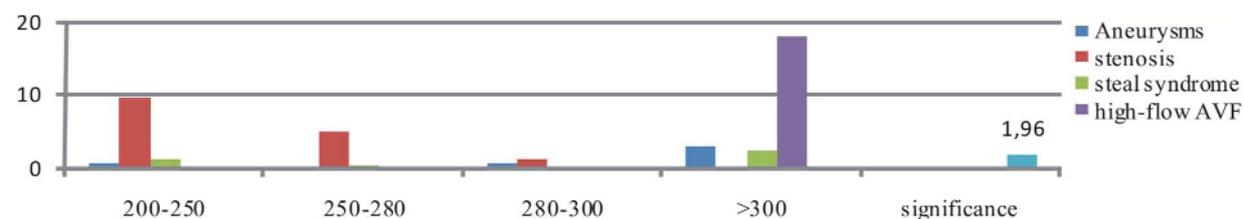


Figure 5. Correlations between AVF complications and dialysis blood flow

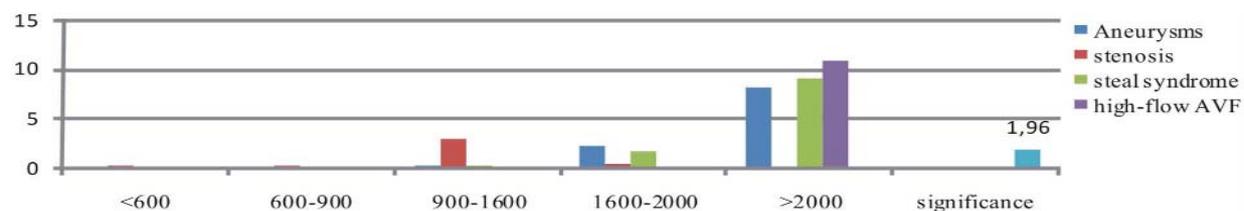


Figure 6. Correlations between AVF complications and fistula blood flow

observational study aimed to evaluate the prevalence of silent AVF complications in a heterogeneous population of dialysis patients; the impact of several factors known to influence the secondary patency of dialysis fistula was searched, noted and statistically analyzed.

This research has one unique characteristic: it presents the real situation of the vascular access in a random sample of dialysis population – all the ESRD patients admitted in the hospital in a definite period of time. Other studies published in the literature showed the prevalence of AVF complications in a single hemodialysis center, or presented the incidence of these complications in a surgery department – after performing an AVF or when the patients were admitted for postoperative complications. We considered useful to analyze this heterogeneous sample of hospitalized dialysis patients, showing the prevalence of silent AVF complications in patients admitted for various reasons unrelated to vascular access; our patients came from 11 different dialysis centers located in the southern region of Romania.

It is known that AVF complications accounts for over 20% of hospitalizations recorded for dialyzed patients [1]. Many studies have been made and focused on analyzing the vascular access complications only when they required hospitalization or / and surgery. In this study we presented AVF complications that were not clinically manifested and therefore did not represent the admission criteria. The prevalence of silent AVF complications was found to represent 61.4% of all the patients we recorded in the study.

The reported rate of AVF complications in other trials varies widely, between 14% and 67% – depending on the site chosen for the survey (a dialysis center or a vascular surgery department), the age of the analyzed fistulas (surveys starting immediate after fistula formation or at any time in patients life) or the area from which the patients originate (different guidelines for fistula creation and monitoring) [7,15-18].

Aneurysms of AVF had a prevalence of 14.57% and were strongly correlated with higher fistulas blood flow (OR 8.35) and the duration of dialysis in years (or 13.3). This is a higher rate in comparison to other studies that analyze only symptomatic patients or those who required surgery [7,11,19,20].

In this study vascular stenosis were the most frequent complications (31.49%). Their presence was correlated with advanced age (OR 4.63),

ischemic nephropathy as the underlying cause of CKD (OR 9.87), cardiac failure as comorbidity (OR 5.11) and the lower dialysis blood flow values which this pathology required (OR 9.87). Elderly patients with compromised vascular endothelium, previously chronic cardiac disease and history of central venous catheters are the most affected by this AVF pathology [13]. Thrombosis was a rare complication in this study, mainly because when it appears it is a serious and noisy event and needs immediate therapeutic approach [11,16].

Arterial steal syndrome was found in 7.34% of cases, a lower incidence in comparison with other literature data [11,21,22]. Nevertheless, 3 patients declared they had symptoms of ischemic neuropathy, neglected so far. This complication was correlated with low BMI (OR 13.5), high fistula flow rates (OR 9.29), ischemic nephropathy (OR 6.45) and coronary ischemic disease (OR 8.39).

High-flow AVF was found in 11 patients (5%) and was associated with high-flux dialysis (OR 18.32) – the strongest correlation in our study – and high ultrafiltration volumes (4.89). All the affected patients had symptoms of cardiac failure. Left ventricular hypertrophy caused / exacerbated by fistula development is an irreversible complication, since closing the AVF do not provide a full restoration of cardiac function [13,14,23].

An important predisposing factor in our study is age over 65 years, therefore we sustain a prudent approach in performing AVF in elderly [7,24]. The 2011 study from Mayo Clinic did not found an interference between advanced age and fistula complications, but there were reviewed only the complications which required surgery or were fatal for fistula functioning; nevertheless, they recommended that native fistula should not be the first choice for older patients [7,25].

As a second important finding of this study, the most frequent dialysis practice encountered as a contributing factor for AVF complications is high-flux dialysis. It has its advantages (better middle-molecular substances removal, improved control of hyperphosphatemia and anemia) but further studies are needed to determine its potential risks for developing fistula complications [7,26-28].

We found a prevalence of 61.4% of AVF complication in patients not admitted for vascular access problems. This high prevalence shows that the problem is bigger than we think and is worrisome. We must perform a much appropriate

surveillance and periodically assess of the vascular access function; it appears that all the methods used today for monitoring the AVF patency are far from being enough.

CONCLUSIONS

Silent complications of AVF are frequent and they represent a serious problem. The periodic assessment of the vascular access should be intensified and made with the utmost attention to detect and treat all the complications before they become clinically manifest and interfere with dialysis adequacy.

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