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Complications of Arteriovenous Fistulas in Chronic Hemodialysis Patients in Niamey: Monitoring and Management at the HNABD Nephrology Department

Zeinabou Maiga Moussa Tondi[1,2], Djibrilla Bonkano Baoua[1,2*], Amadou Daouda[2,3], Abdoul Kader Mahamadou Hima[3], Tidjani Mahamat Hissene[2,4], Moctar Halidou Barkire[4], Odilon Francis Azon[1], Rachid Sani[2,5]

[1]Nephrology Department, Amirou Boubacar Diallo National Hospital, Niamey, Niger
[2]Faculty of Health Sciences, Abdou Moumouni University, Niamey, Niger
[3]Cardiovascular Surgery Department, Niamey General Reference Hospital, Niamey, Niger
[4]Radiology Department, Niamey General Reference Hospital, Niamey, Niger
[5]Niamey National Hospital, Niamey, Niger
Email: *bbdjibrilla@gmail.com

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Abstract

Introduction: The arteriovenous fistula (AVF) is the vascular approach of choice for chronic hemodialysis, due to its durability and low morbidity and mortality. However, it remains exposed to numerous complications that can compromise its proper functioning. **Objective:** To describe the complications of AVFs and evaluate their management in chronic haemodialysis patients in the nephrology department of the Hôpital National Amirou Boubacar Diallo in Niamey. **Methodology:** Prospective, descriptive and analytical study conducted from August 2023 to July 2024. Chronic hemodialysis patients with AVF were included. Doppler ultrasound and clinical evaluation were performed. Statistical analysis was performed with SPSS 25.0 and Epi Info 7.2.5.0. **Results:** Of 126 patients included (mean age: 46 years, sex ratio M/F = 1.93), 42.86% presented with an AVF complication. False aneurysm was the main complication (46.3%), followed by primary failure (22.2%) and thrombosis (18.5%). Management was mainly by medication in 92.3% of cases, but the outcome was favorable in only 38.5%. Several risk factors were identified, including anemia, female gender and prolonged AVF lifespan. **Conclusion:** Complications of AVFs are frequent in Niamey, with a predominance of false aneurysms. Early detection by Doppler ultrasound and a multidisciplinary approach are essential to improve patient management and prognosis.

Keywords

Monitoring and Management, Complications, Arteriovenous Fistula, Chronic Hemodialysis Patients, Niger

1. Introduction

End-stage renal disease (ESRD) is a growing public health problem in developing countries, where access to replacement therapy remains limited. Among extrarenal purification modalities, chronic hemodialysis is the most widely used technique in Niger, due to its relative availability and lower cost compared with renal transplantation.

Efficient implementation of hemodialysis depends on the availability of a reliable vascular access, ensuring sufficient blood flow. The native arteriovenous fistula (AVF) is the approach of choice because of its longevity, low incidence of infection and lower cost than central venous catheters or prosthetic grafts. However, its implementation and maintenance are not without complications, some of them serious, which can compromise continuity of dialysis and patient survival [1]-[5]. However, a meta-analysis suggests that US-guided AVF cannulation, when performed by renal nurses, may result in a higher successful cannulation rate and reduced complications such as hematoma, oozing blood, and infiltration compared to the conventional blind needling method [6]. Pharmacotherapeutic–mechanical thrombolysis showed promising outcomes, resulting in many centers adopting an endovascular-first approach [7].

The main complications encountered are thrombosis, stenosis, false aneurysms, hemorrhage, hyperflow, and primary failure. These complications are often linked to inadequate monitoring, inappropriate technical procedures or clinical factors such as diabetes, anemia or coagulation disorders [8]-[12]. Their management remains a challenge in resource-limited settings, due to a lack of specialized equipment (Doppler ultrasound, angioplasty, vascular surgery), a lack of continuing education, and the absence of standardized protocols. In sub-Saharan Africa, very few patients begin dialysis with an arteriovenous fistula [13] [14].

To date, few local studies have exhaustively documented the nature and frequency of AVF complications in Niger or the modalities of their management. It is in this context that we initiated this prospective study in the nephrology department of the Hôpital National Amirou Boubacar Diallo in Niamey, with the main objective of describing the complications of AVF in chronic haemodialysis patients and assessing their management in our context.

2. Methodology

2.1. Type and Scope of Study

This is a prospective, descriptive and analytical study conducted over a 12-month

period, from August 1, 2023 to July 31, 2024, in the nephrology-hemodialysis department of the Hôpital National Amirou Boubacar Diallo (HNABD) in Niamey, Niger.

2.2. Study Population

All chronic hemodialysis patients with an arteriovenous fistula (AVF), functional or not, who agreed to participate in the study were included.

Inclusion criteria were:

- Age ≥ 13 years;
- Patient on chronic hemodialysis (seniority ≥ 3 months);
- Presence of a native or prosthetic AVF, regardless of its functional status;
- Informed consent from the patient or legal guardian.

Non-inclusion criteria included:

- Patients with a central venous catheter without AVF;
- Patients on acute dialysis or awaiting fistula creation;
- Incomplete or unusable records.

2.3. Data Collected

Data were collected using a standardized form including (Table 1):

- Sociodemographic data (age, sex, medical history);
- Clinical data (initial nephropathy, duration of dialysis, number of weekly sessions, type and site of AVF);
- Elements of clinical monitoring of AVF (presence of thrill, signs of infection, swelling, bleeding, collateral circulation, signs of Hyperflow);
- Biological data (hemoglobin, blood glucose, creatinine, hemostasis);
- Doppler imaging results (when performed);
- Complications observed and management (medical or surgical treatment, evolution).

Table 1. Clinical and demographic characteristics of included patients.

Variables	Values
Total number of patients included	126
Mean age (± standard deviation)	46 years ± 14 years
Predominant age range	40 years - 49 years (30.2%)
Male sex	65.9% (n = 83)
Hypertension	95.2% (n = 120)
Diabetes	11.1% (n = 14)
Chronic glomerulonephritis	34.9% (n = 44)
Mean duration of hemodialysis	36.1 months ± 25.2 months
Hemodialysis sessions per week	2 sessions for 96.0% of patients

2.4. Diagnostic Tools and Monitoring

Each patient underwent a complete clinical examination, carried out in the dialysis room by the medical team. Doppler ultrasound of the AVF was performed on the ward for patients who had access to it, using a Mindray device with a high-frequency linear probe.

This study was performed using a Mindray ultrasound machine.

The Doppler ultrasound examination follows a specific methodology:

- Examination of superficial vessels requires a high-frequency linear ultrasound probe (7 - 12 MHz).
- Examination of the deep venous network of the superior vena cava and subclavian arteries using a low-frequency convex probe (3 - 6 MHz).

Doppler ultrasound allowed us to measure blood flow and obtain a precise anatomical and hemodynamic analysis of arteriovenous fistulas, particularly to detect venous hypoperfusion or hyperperfusion, stenosis, false aneurysms, or thrombosis (Table 2).

The quality criteria for an arteriovenous fistula were divided into two groups:

- Anatomical conditions:
  - Caliber of at least 6 mm.
  - Location is less than 6 mm under the skin.
  - The trajectory is long enough for the insertion of two needles to be sufficiently distant to avoid any recirculation phenomenon.
- Arteriovenous fistula flow greater than or equal to 600 ml/min.

Table 2. AVF types and anatomical characteristics.

AVF Characteristics	Frequency (n)	Percentage (%)
Type of native AVF	121	99.2
Prosthetic AVF	1	0.8
Radiocephalic AVF	77	61.1
Humerocephalic AVF	49	38.9
Distal left location	64	50.8
Average lifespan of AVFs	-	33.1 months ± 24.8 months

2.5. Definitions of Operational Variables

- A pseudo-aneurysm or false aneurysm is a perivascular collection that keeps continuity with the vessel lumen through a breach or collar, and unlike the aneurysm, has no wall of its own.
- Hyperflow: blood flow within a typical dialysis access (1500 - 4000 mL/min).
- Primary failure is the permanent AVF failure before it is suitable for haemodialysis. It occurs within 3 months of AVF implantation due to insufficient inflow or inappropriate remodeling of the incoming artery or outgoing vein.
- Stenosis: In haemodynamics, this term defines vessel lumen narrowing result-

ing from a parietal atherosclerotic plaque, neointimal hyperplasia, or obstructive thrombus. Hemodynamically significant stenosis: >50% reduction in the normal caliber of the vessel associated with one or more hemodynamic, functional, or clinical abnormalities that cannot be explained by other causes, including:

Monitoring measures: decreased flow—increased venous pressures—high recirculation rate—unexplained decrease in hemodialysis volumes—Doppler abnormalities.

Monitoring measures: persistent edema of the extremities—increased bleeding time—decreased pulsatility or clinical flow of the AVF—altered thrill on Auscultation.

2.6. Ethical and Professional Considerations

Our study was conducted after submitting a research authorization request to the Dean of the Faculty of Health Sciences (FSS) at Abdou Moumouni University (UAM). We then obtained approval from the Dean of the FSS and the Director of the HNABD.

The informed consent of each patient included in the study was obtained.

2.7. Statistical Analysis

Data were entered using Microsoft Excel 2013 and analyzed with Epi Info version 7.2.5.0 and SPSS version 25.0.

- Quantitative variables were expressed as mean ± standard deviation or median according to distribution.
- Qualitative variables were expressed as numbers and percentages.
- The Chi² test (or Fisher's exact test if necessary) was used to compare proportions.
- The threshold of statistical significance was set at $p < 0.05$.

3. Results

3.1. General Patient Characteristics

Of a total of 225 patients on chronic hemodialysis during the study period, 126 were included, representing an inclusion rate of 56%.

The mean age of the patients was 46 years ± 14 years (extremes: 13 to 70 years). The most common age group was 40 to 49 (30.2%). Males predominated, accounting for 65.9% of cases (n = 83), giving an M/F sex ratio of 1.93.

Hypertension was the most frequent comorbidity (95.2%, n = 120), followed by diabetes (11.1%) and heart failure (10.3%). Regarding the etiology of CKD, chronic glomerulonephritis was the most common (34.9%), followed by undetermined nephropathy (32.5%) and hypertensive nephropathy (22.2%).

The mean duration of hemodialysis treatment was 36.1 months ± 25.2 months (extremes: 3 to 204 months). The vast majority of patients (96%) received 2 weekly sessions.

3.2. Arteriovenous Fistula Characteristics

Native arteriovenous fistula (AVF) was the predominant vascular approach, found in 99.2% of cases (n = 121). Only one patient had a prosthetic fistula.

Fistulas were predominantly radiocephalic (61.1%, n = 77), followed by humerocephalic (38.9%, n = 49). The most frequent site of creation was the distal left arm (50.8%), followed by the proximal left arm (30.9%).

Right laterality was dominant in 81.8% of cases. The mean lifespan of the AVFs was 33.1 months ± 24.8 months (extremes: 2 to 196 months).

3.3. Clinical Data on Examination

On examination, more than half of AVFs were clinically normal (55.6%). The most frequent abnormalities were:

- **Swelling:** 30.2% (n = 38)
- **Inflammation:** 14.3% (n = 18)
- **Edema:** 7.9% (n = 10)
- **Collateral circulation:** 5.6% (n = 7)

Thrill was present and satisfactory (>10 cm) in 80.9% of cases.

Biologically, the majority of patients were anemic, with mild to moderate anemia in 86.7% of cases.

3.4. Doppler Ultrasound Monitoring

Doppler ultrasound was performed in 51.6% of patients (n = 65). Of these, the examination was normal in 40% (n = 26).

3.5. AVF Complications (Table 3)

Table 3. Observed complications, treatments, and evolution.

Complication	Frequency (n)	Percentage (%)	Treatment Received (%)	Favourable Outcome (%)
False aneurysm	25	46.3	40.0	36.0
Primary failure	12	22.2	16.7	33.3
Thrombosis	10	18.5	76.9	30.8
Stenosis	5	9.3	-	-
Hyperflow	5	9.3	-	-
Hemorrhage	3	5.6	-	-
Total patients treated	13	24.1	-	**38.5%** (all patients)

Complications were observed in 42.9% of patients (n = 54). The main complications were

- **False aneurysm:** 46.3% (n = 25)
- **Primary failure:** 22.2% (n = 12)

- **Thrombosis:** 18.5% (n = 10)
- **Stenosis:** 9.3%
- **Hyperflow:** 9.3%
- **Hemorrhage:** 5.6%

3.6. Management of Complications

Of patients presenting complications, 24.1% (n = 13) received treatment. Treatment was drug-based in 92.3% of cases (n = 12), and mainly involved:

- **Anti-inflammatories:** 92.3%
- **Anticoagulants:** 76.9%

Thrombosis was the complication requiring the most treatment (76.9% of cases treated).

Post-treatment outcome was favorable in 38.5% of cases, while loss of AVF was observed in 61.5% of treated cases.

This situation can be explained by a lack of technical facilities. In most cases, fistulas are closed by surgeons in the event of fistula rupture or significant hyperflow leading to heart failure.

3.7. Statistical Analysis

The statistically significant relationships identified were as follows:

- **False aneurysm and anemia (low Hb):** p = 0.0425
- **Thrombosis and anemia:** p = 0.03
- **Thrombosis and female sex:** p = 0.04
- **Stenosis and AVF lifespan:** p = 0.0005
- **False aneurysm and AVF lifespan:** p = 0.0001
- **Overflow and AVF lifespan:** p = 0.0001

In multivariate logistic regression, age, diabetes, age at dialysis, hemoglobin, anemia, and female sex remain independent predictors (Figure 1).

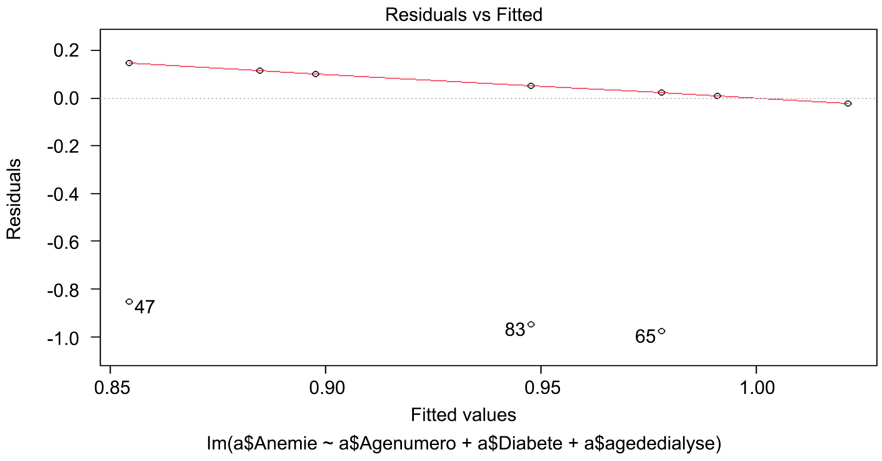

Figure 1. 1.35% of factors such as age, diabetes, and age at dialysis explain the occurrence of anemia (adjusted R-squared = 1.35%). The model is statistically very significant ($p < 0.05$), p = 0.023.

In multivariate logistic regression, age, diabetes, age at dialysis, and gender remain independent predictors (Figure 2).

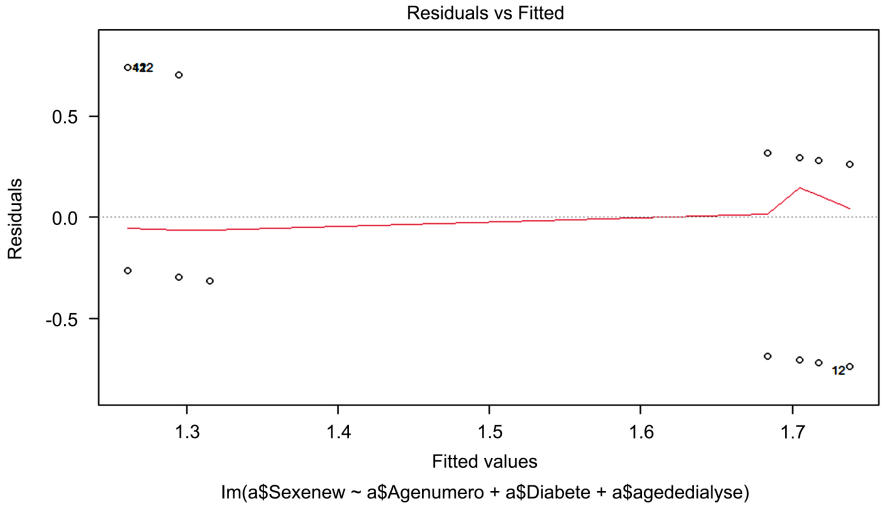

Figure 2. 5.66% of factors such as age, diabetes, and dialysis age explain the link to gender (adjusted R-squared = 5.66%). The model is statistically highly significant ($p < 0.05$), $p = 0.017$.

4. Discussion

4.1. Predominance of Native AVF

In our study, the native arteriovenous fistula was the most commonly used vascular approach (99.2%), with a predominance of radio-cephalic AVFs (61.1%). This practice is in line with international recommendations, which favor native AVF as the first choice of vascular approach due to its longevity, low infection rate, and reduced cost [1] [2].

Our results concur with those of Karar *et al.* in Algeria [15], who reported a similar proportion of native AVFs, and confirm the rarity of using prosthetic grafts in resource-limited countries, due to economic constraints and an insufficient technical platform.

4.2. High Frequency of Complications

The frequency of complications in our series (42.9%) is high, but remains consistent with African data reporting significant morbidity associated with AVFs [15]-[17]. This frequency may be linked to inadequate monitoring, repeated puncture at the same site, the absence of a structured Doppler follow-up program, and insufficient training of nursing staff.

4.3. Complication Profile

Contrary to many studies in the literature, in which thrombosis is the most frequent complication [16] [17], our series shows a predominance of false aneurysms (46.3%). This specificity could be explained by repeated punctures at the same

site, poor needling technique, and lack of systematic rotation of puncture sites, exacerbated by the absence of prior ultrasound identification.

Thrombosis, although in 3rd place, remains a dreaded complication, occurring in 18.5% of cases. In our study, thrombosis was significantly associated with anemia ($p = 0.03$) and female gender ($p = 0.04$). This latter finding is in line with several publications suggesting a greater susceptibility of women to thrombosis, in relation to vascular caliber and hormonal factors [17]-[21].

4.4. Primary Failure and Risk Factors

Primary failure accounted for 22.2% of complications. Contrary to some publications [18] [19], we found no significant association between primary failure and diabetes ($p = 0.15$), although this comorbidity is known to favor diffuse arterial damage and mediacalcosis, which impede AVF maturation. This result may be linked to the modest size of our sample or to an underestimation of associated vascular lesions.

4.5. Correlations between Lifespan and Degenerative Lesions

We found a significant association between prolonged AVF lifespan and certain degenerative complications such as stenosis ($p = 0.0005$), false aneurysm ($p = 0.0001$), and hyperflow ($p = 0.0001$). These results reinforce the idea that prolonged exposure to high arterial pressures and repeated punctures induces vascular structural remodeling [20].

4.6. Monitoring and Imaging Still Inadequate

Doppler ultrasonography was performed in only 51.6% of patients, despite being a fundamental tool for detecting silent or sub-clinical complications [1] [3]. Its limited access reflects the structural constraints of our healthcare system. The development of a systematic Doppler screening strategy, even if targeted, could significantly improve the early detection and longevity of AVFs.

4.7. Treatment Modalities and Outcome

Most complications were treated with drugs (92.3%), mainly anti-inflammatories and anticoagulants. This finding is in line with data from Baldé *et al.* in Guinea [17]. However, this approach often remains palliative. The failure rate (loss of AVF in 61.5% of cases treated) underlines the need to integrate vascular surgery and interventional radiology into the local therapeutic arsenal.

4.8. Study Limitations

This study has certain limitations:

- The monocentric nature of the study limits the generalizability of the results;
- Unequal access to Doppler ultrasound reduces diagnostic completeness;
- Lack of long-term follow-up of treated patients makes it impossible to assess secondary patency of AVFs.

5. Conclusions

Arteriovenous fistulas (AVFs) remain the preferred vascular approach for chronic hemodialysis in Niger, despite a context of limited resources. Our study highlights a high frequency of complications, affecting nearly 43% of patients, with an unusual predominance of false aneurysms, followed by primary failure and thrombosis. These complications seriously compromise the quality and continuity of care.

Doppler monitoring remains inaccessible, and management remains largely drug-based, with a high rate of functional loss of AVFs. Factors such as anemia, duration of AVF evolution, female gender, and lack of standardized protocols contribute to this situation.

These results underline the need to reinforce clinical and paraclinical monitoring of AVFs, to structure team training, and to improve access to surgical or interventional therapeutic alternatives.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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