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Native arteriovenous fistulae: risk factors involved in primary maturation failure

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ABSTRACT

Introduction: Primary failure includes early thrombosis and maturation failures.

Objectives: To determine the risk factors associated with primary failure of native fistulas and their relationship with survival. To analyse the sonographic differences between mature fistulas and fistulas with maturation failure.

Material and Method: Observational and retrospective study. Variables: sociodemographic, anthropometric, comorbidities, blood and ultrasound parameters. Statistical analysis: Descriptive. Logistic regression. Kaplan-Meier method.

Results: Sample 65 native fistulas, 72.3% male. Age 69.7 years. 60% mature fistulas and 40% fistulas with primary failure (20% maturation failure and 20% early thrombosis). Risk factors for maturation failure: arterial diameters <2mm (OR:16.8; p=0.016). Risk factors for early thrombosis: age ≥65 years (OR:5.44; p=0.014), weight (OR:1.04;p=0.02) and body mass index (OR:1.17;p=0.027). Monocytes as a protective factor for early thrombosis (OR:0.0142; p=0.029).
People ≥ 65 years old, obese, and with arterial diameters <2mm had lower survival. Mature fistulas had a significantly higher vein diameter, peak systolic velocity, and vascular access flow (p<0.001).

Conclusions: Fistulas performed with arterial diameters <2mm present a higher risk of maturation failure. The higher the age, weight, and body mass index, the higher the risk of early thrombosis. The fewer monocytes, the lower the risk of early thrombosis. Age, arterial diameter, and weight influence survival. There are ultrasound differences between mature fistulae and fistulae with maturation failure.

Keywords: haemodialysis; native arteriovenous fistula; primary failure; doppler ultrasound; survival.

RESUMEN

Fístulas arteriovenosas nativas: Factores de riesgo implicados en el fallo primario de maduración

Objetivo: El fallo primario incluye la trombosis precoz y los fallos de maduración.

Objetivos: Determinar los factores de riesgo asociados al fallo primario de fístulas nativas y su relación con la supervivencia. Analizar las diferencias ecográficas entre fístulas maduras y fístulas con fallos de maduración.

Material y Método: Estudio observacional y retrospectivo. Variables: sociodemográficas, antropométricas, comorbilidades, parámetros sanguíneos y ecográficos. Análisis estadístico: Descriptivo. Regresión logística. Método de Kaplan-Meier.

Resultados: Muestra 65 fístulas nativas, 72,3% hombres. Edad 69,7 años. 60% fístulas maduras y 40% fístulas con fallo primario (20% fallo de maduración y 20% trombosis precoz). Factores de riesgo de fallos de maduración: diámetros arteriales <2 mm (OR:16,8;p=0,016). Factores de riesgo de trombosis precoz: Edad ≥65 años (OR:5,44;p=0,014), peso (OR:1,04;p=0,02) e índice de masa corporal (OR:1,17;

p=0,027). Monocitos factor protector de trombosis precoz (OR:0,0142;p=0,029).
Personas ≥65 años, obesas y con diámetros arteriales <2 mm presentaron menor supervivencia. Diámetro de vena, velocidad pico sistólica y flujo del acceso vascular significativamente mayores en fístulas maduras(p<0,001).

Conclusiones: Fístulas realizadas con diámetros arteriales <2 mm presentan mayor riesgo de fallos de maduración. A mayor edad, peso e índice de masa corporal mayor riesgo de trombosis precoz. A menos monocitos, menos riesgo de trombosis precoz. La edad, el diámetro arterial, y el peso influyen en la supervivencia. Existen diferencias ecográficas entre fístulas maduras y fístulas con fallos de maduración.

Palabras clave: hemodiálisis; fístula arteriovenosa nativa; fallo primario; ecografía doppler; supervivencia.

INTRODUCTION

In our country, 78.4% of patients with advanced chronic kidney disease chose hemodialysis (HD) as their renal replacement therapy (RRT)[1]. Vascular access is the most important factor determining the success or failure of HD programs[2,3]. The native arteriovenous fistula (nAVF) is the vascular access of choice because of its greater long-term patency and lower rates of complications, healthcare expenditure, and mortality when compared with prosthetic arteriovenous fistulas and central venous catheters[3-6].

Maturation is a process that begins after the creation of the arteriovenous anastomosis and ends when the nAVF is suitable for hemodialysis. An nAVF is suitable for HD when the venous diameter is ≥4 mm and the vascular access flow is ≥5 00 mL/min[7-9]. These parameters are generally reached after 6 weeks of maturation, although completion may be delayed up to 3–6 months[7]. During maturation, the increase in intravascular pressure and blood flow leads to vascular remodeling and vessel dilation[3,5,10,11]. Vascular remodeling is affected by age, surgical factors, and patient comorbidities; these factors predispose to nAVF maturation failure and vascular access thrombosis[5,6,11,12].

Primary failure occurs when an nAVF is not suitable for HD at three months of maturation and includes early thrombosis and nAVF maturation failure[2,11-14]. It is estimated that 20–50% of arteriovenous fistulas experience primary failure[7,11,14,15]. Clinical and ultrasound criteria are used to determine whether an nAVF shows maturation failure or early thrombosis[11].

Several factors have historically been associated with primary nAVF failure: age, female sex, comorbidities (diabetes, obesity, hypertension), chronic inflammation, laboratory abnormalities, and the arterial/venous diameter used during nAVF creation[3,4,6,11,14,16,17]. However, the role of these factors in primary failure and nAVF survival is not clearly defined[14].

Therefore, the overall objective of this study is to determine the risk factors associated with primary failure of nAVFs in HD patients. The specific objectives are:

- To establish the relationship between the risk factors associated with primary failure and the cumulative survival of nAVFs.
- To determine the ultrasound differences between mature nAVFs and those with maturation failure during the first three months after creation.

MATERIAL AND METHOD

Design and setting: We conducted an observational study with retrospective data collection from February through March 2024 in the Vascular Access Clinic for Hemodialysis at *Hospital Universitario Miguel Servet de Zaragoza* (Zaragoza, Spain).

Population and sample: HD patients who received an nAVF at the hospital between January 1st, 2023, and January 31st, 2024.

Inclusion criteria: Patients >18 years, with an nAVF with ≥3 months of maturation as of January 31st, 2024, and patients with nAVF thrombosis during the first three months of maturation.

Exclusion criteria: Patients whose nAVF required surgical repair during the first three months of maturation, and patients with prosthetic arteriovenous fistulas.

For patients who had more than one nAVF during the study period, each vascular access was considered independently, even if belonging to the same patient.

Study Variables
Sociodemographic: age (years), sex (male/female). *Anthropometric:* weight (kg), height (m), body mass index (BMI). *Comorbidities:* hypertension, diabetes, peripheral arterial disease, hyperparathyroidism, dyslipidemia. *nAVF characteristics:* type (radiocephalic, brachiocephalic, brachiobasilic), arterial and venous diameters used for nAVF creation (mm). *Laboratory parameters:* pH, bicarbonate (mmol/L), PCO_2 (mmHg), PO_2 (mmHg), potassium (mmol/L), PTH (pg/mL), iron (µg/dL), ferritin (ng/dL), C-reactive protein (mg/dL), urea (mg/dL), creatinine (mg/dL), calcium (mg/dL), phosphorus (mg/dL), total cholesterol (mg/dL), triglycerides (mg/dL), albumin (g/dL), total white blood cell count (10^3/µL), neutrophils (10^3/µL), monocytes (10^3/µL), lymphocytes (10^3/µL), hemoglobin (g/dL), hematocrit (%), and platelets (10^3/µL)[3,11,14-16,18].

The laboratory test closest to the nAVF creation date was used[14]. BMI was calculated using the Quetelet index and categorized by WHO criteria[19]: normal weight (18.5–24.9 kg/m²), overweight (25–29.9 kg/m²), and obesity (≥30 kg/m²). Age was categorized (≥65 *vs* <65 years)[3,4,11,14,15,20], as were arterial

diameters (≥2 mm *vs* <2 mm)[7-9,16,18] and venous diameters (≥2.5 mm *vs* <2.5 mm)[7,8,16,18,20].

The remaining variables were obtained through Doppler ultrasound. Three ultrasound evaluations were performed on the native arteriovenous fistulas (nAVFs) at 15, 45, and 90 days of maturation. The ultrasounds were performed by the nephrologist and the nurse from the Hemodialysis Vascular Access Clinic using a Hitachi-Aloka F31 ultrasound system. The ultrasound data collected included: anastomosis diameter (mm), peak systolic velocity (PSV) of the anastomosis and of the brachial artery (cm/s), resistance index of the anastomosis and of the brachial artery, vein diameter (mm), and vascular access flow (QA) (mL/min). All QA and vein-diameter measurements were obtained at the same anatomical sites: QA was measured three centimeters above the bifurcation of the brachial artery, and vein diameter was measured three centimeters from the arteriovenous anastomosis[21]. These measurements were not performed in thrombosed nAVFs. To obtain QA, three measurements were taken and the mean value was used.

The presence or absence of primary failure was also documented, as well as the type of failure—either early thrombosis (ET) or maturation failure (MF). The following diagnostic criteria were applied:

- **Early thrombosis (ET):** Thrombosis occurring within the first three months of maturation[2,13,17]. Diagnosis was established through physical examination (absence of thrill and bruit) and ultrasound findings (absence of venous compressibility, absence of Doppler and color flow, and presence of high-resistance waveforms in the feeding artery). When all these signs were present, a diagnosis of early thrombosis of the nAVF was established[7-9].
- **FMaturation failure (MF):** An nAVF was considered mature when it presented a QA ≥500 ml/min and a vein diameter ≥4 mm at three months of maturation[7-9,11]. Therefore, nAVFs were classified as MF when they did not meet both criteria at 3 months.

Ethical considerations: Permission for this study was obtained from *Hospital Universitario Miguel Servet* and the Research Ethics Committee of the Autonomous Community of Aragón (CEICA), approval report CEICA (C.I. PI24/032). The committee granted exemption from informed consent because the data extracted from the electronic health records were anonymized.

Statistical analysis: The Jamovi® software version 2.3.28 was used. The Shapiro–Wilk test assessed the normality of quantitative variables. Quantitative variables were expressed using measures of central tendency (mean and median) and dispersion (standard deviation and interquartile range), depending on whether they followed a normal distribution. Comparisons of quantitative variables were performed using the independent-samples Student's t test (normal distribution) or the Mann–Whitney U test (non-normal distribution). Qualitative variables were expressed as frequency and percentage. Comparisons of qualitative variables used contingency tables with the Chi-square test or Fisher's exact test, as appropriate. Risk factors for MF and ET were identified using univariate and multivariate logistic regression. The Kaplan–Meier method was used to calculate nAVF survival at 15, 45, and 90 days of maturation. Additionally, survival was analyzed by sex, age, BMI, and arterial diameter used to create the nAVF. Statistical significance was set at p<0.05.

RESULTS

The sample consisted of 65 nAVFs from 63 patients. Median age was 69.7 years (IQR, 43–85). A total of 72.3% were men (n=47) and 27.7% women (n=18). Of the accesses, 66% were radiocephalic nAVFs (n=44), 20% brachiocephalic (n=13), and 12.3% brachiobasilic (n=8) **(table 1)**.

A total of 60% (n=39) were mature nAVFs and 40% (n=26) had primary failure (20% MF [n=13] and 20% ET [n=13]) **(table 1)**.

A statistically significant association was found between MF and the arterial diameter used to create the nAVF (p=0.036). ET was significantly associated with age (p=0.048), weight (p=0.049), BMI (p=0.047), and monocyte count (p=0.021) **(table 1).**

Univariate analysis of risk factors for MF showed that using arterial diameters <2 mm was a risk factor (OR, 16.8; 95%CI, 1.67–169; p=0.016). In the multivariate analysis, arterial diameter <2 mm remained an independent risk factor (OR, 20.12; 95%CI, 1.55–283; p=0.020) **(table 2)**.

Univariate analysis for ET showed that age ≥65 years (OR, 5.44; 95%CI, 1.4–21.1; p=0.014), weight (OR, 1.04; 95%CI, 1.01–1.17; p=0.02), and BMI (OR, 1.17; 95%CI, 1.02–1.35; p=0.027) were risk factors. Conversely, monocytes acted as a protective factor: lower monocyte counts were associated with reduced ET risk (OR, 0.0142; 95%CI, 3.1–4–0.64; p=0.029). Multivariate analysis showed that being overweight was an independent risk factor for ET (OR, 31.28; 95%CI, 1.46–642; p=0.044) **(table 2**).

The cumulative survival of nAVFs at 15, 45, and 90 days of maturation was 73.3%, 72.6%, and 63.6%, respectively. Patients ≥65 years, those whose nAVFs were created using arterial diameters <2 mm, and those with obesity had lower cumulative survival at all time points. Cumulative survival dropped markedly at 90 days in patients ≥65 years (50.6%), in those with arterial diameter <2 mm (37.5%), and in patients with obesity (32.1%) (**table 3** and **figure 1**).

Ultrasound follow-up at 15, 45, and 90 days was performed on 52 nAVFs, of which 75% were mature (n=39) and 25% had MF (n=13). At all time points, vein diameter, QA, and brachial-artery PSV were significantly higher in mature

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Table 1. Mature nAVFs vs. nAVFs with maturation failure and early thrombosis: sociodemographic, anthropometric, nAVF characteristics, and laboratory variables.

Variables	FAVn maduras (n=39)	Primary Failure (n=26)			
		Maturation Failure (n=13)	p	Early Thrombosis (n=13)	p
Sociodemographic variables					
Sex (%)					
Men	28 (71.7)	10(76.9)	0.25[1]	9(69.2)	0.47[1]
Women	11 (28.3)	3(23.1)		4(30.8)	
Age (years)	68.5(IQR:43-84)	67(IQR:48-85)	0.57[2]	74(IQR:49-88)	**0.048**[2]
Categorized age (%)					
< 65 years	12(30.7)	3(23.1)	0.5[1]	2(15.4)	**0.01**[1]
≥ 65 years	27(69.3)	10(76.9)		11(84.6)	
Anthropometric measures					
Weight (kg)	77.2(IQR:56-118)	81.4(IQR:57-108)	0.14[2]	82.3(IQR:73-131)	**0.049**[2]
Height (m)	1.67±0.15	1.69±0.07	0.4[3]	1.72±0.06	0.15[3]
BMI (kg/m²)	22.6(IQR:17.5-34)	23.1(IQR:18.2-31.2)	0.18[2]	23.6(IQR:21.2-37)	**0.047**[2]
Categorized BMI (%)					
Normal	25(64.1)	4(30.7)	0.08[1]	3(23.1)	
Overweight	12(30.7)	7(53.8)		7(53.8)	0.16[1]
Obesity	2(5.2)	2(15.5)		3(23.1)	
Comorbidities (%)					
Hypertension	38(97.4)	12(92.3)	0.41[4]	13(100)	0.5[4]
Diabetes	16(41.2)	6(46.1)	0.7[4]	5(38.4)	0,84[4]
Peripheral arterial disease	9(23.07)	4(30.7)	0.7[1]	3(23.07)	1[1]
Previous central venous catheter	4(10.2)	-	-	5(38.4)	0.16[1]
Hyperparathyroidism	2(5.1)	2(15.3)	0.2[1]	-	-
Dyslipidemia	31(79.4)	11(84.6)	0.78[4]	9(69.2)	0.7[4]
nAVF characteristics					
Type of nAVF (%)					
Radiocephalic	23(58.9)	11(84.6)	0.17[4]	10(86.9)	0.34[4]
Brachiocephalic	9(23.1)	1(7.7)	0.41[1]	3(13.1)	0.93[1]
Brachiobasilic	7(18)	1(7.7)	0.66[1]	-	-
Artery diameter (mm)	2.65±0.7	2.31±0.6	**0.036**[3]	2.39±0.61	0.15[3]
Categorized artery diameter (%)					
≥ 2 mm	38(97.4)	4(30.8)	**0.003**[1]	12(92.3)	0.7[1]
< 2 mm	1(2.6)	9(69.2)		1(7.7)	
Vein diameter (mm)	3.2(IQR:1.8-6)	3(IQR:2-4.1)	0.13[2]	3(IQR:1.9-4)	0.47[2]
Categorized vein diameter (%)					
≥ 2,5 mm	31(79.5)	10(76.9)	0.84[1]	10(76.9)	0.78[1]
<2,5 mm	8(20.5)	3(23.1)		3(23.1)	
Laboratory parameters*					
Monocytes (10^3/µL)	0.56±0.17	0.61±0.35	0.07[3]	0.71±0.25	**0.021**[3]

nAVF: native arteriovenous fistula; [1] Fisher's exact test; [2] Mann–Whitney U test; [3] Student's t-test; [4] Statistic used chi[2]

*Only variables with statistically significant associations are shown.

nAVFs compared with those with MF (p<0.001). Additionally, anastomotic PSV at 90 days was significantly higher in mature nAVFs (p<0.001) (**table 4** and **figure 2**).

DISCUSSION

A total of 40% of nAVFs presented primary failure (20% MF and 20% ET). These findings are consistent with the consulted literature, which reports primary failure rates between

Table 2. Univariate and multivariate analysis: risk factors associated with maturation failure and early thrombosis.

	Univariate analysys			Multivariate analysys		
	OR	95%CI	p-value	OR	95%CI	p-value
Risk factors associated with maturation failure						
Sex (female)	1.12	0.17–3.3	0.71	1.82	0.28–11.7	0.52
Age (≥65 years)	1.48	0.34–6.3	0.59	2.21	0.37–13.2	0.38
Weight	1.03	0.98–1.07	0.14	1.05	0.99–1.1	0.061
Artery (<2 mm)	16.8	1.67–169	0.016	20.12	1.55–283	0.020
Vein (<2.5 mm)	1.16	0.25–5.23	0.084	2.71	0.22–26.5	0.39
Risk factors associated with early thrombosis						
Sex (female)	1.07	0.27–4.1	0.91	1.16	0.41–2.56	0.11
Age (≥65 years)	5.44	1.4–21.1	0.014	1.87	0.35–9.9	0.46
Weight	1.04	1.01–1.17	0.02	–	–	–
BMI	1.17	1.02–1.35	0.027	–	–	–
BMI (overweight)	1.03	0.22–4.74	0.96	31.28	1.46–642	0.044
BMI (obesity)	1.17	0.24–0.25	0.081	40.1	1.88–828	0.088
Monocytes	0.0142	3.14–0.64	0.029	0.0607	8.844–4.15	0.16

BMI: Body mass index.

Table 3. Accumulated survival categorized by sex, age, body mass index, and arterial diameter.

	Total	Sex		Age		BMI			Artery diameter	
		Woman (%)	Man (%)	<65 years (%)	≥65 years (%)	Normal weight (%)	Overweight (%)	Obesity (%)	≥2 mm (%)	<2 mm (%)
15 days	73.3	70	74.6	83.4	56.2	75	81.8	38.5	74.7	60
45 days	72.6	70	73.7	82.3	56.2	75	79.7	38.5	73.9	60
90 days	63.6	62.5	64.1	71.3	50.62	68.7	65.4	32.1	63	37.5

20–50%[11,14,15]. MF between 16–30%[2,11,14,22], and ET between 5–30%[2,11,17]. In addition, the variables associated with primary failure in our study (age ≥65 years, elevated weight and BMI, low monocyte levels, and the use of arterial diameters <2 mm when creating the nAVF) are aligned with previous reports[3,4,6,11,14,16,23]. Regarding the type of primary failure, all variables—except arterial diameter <2 mm—were associated with ET, whereas arterial diameters <2 mm were specifically related to MF.

Two studies have linked advanced age with an increased risk of primary failure. Delgado Ramírez et al. reported in their systematic review that advanced age increases the risk of primary failure by 50%[3], while Pérez-Reyes et al. found that the risk increases by 1% per year starting at age 67[4]. In our study, individuals ≥65 years had a higher risk of ET. However, we found no literature specifically associating advanced age with ET. In contrast, Bashar et al. reported an association between advanced age and MF[15].

Currently, the impact of weight on nAVF patency is not yet clear[14]. Nevertheless, both our findings and those of other authors indicate that higher weight is associated with greater primary failure risk[4,11]. Similarly, elevated BMI was associated with primary failure; individuals with BMI ≥25 kg/m² have a 2.4-fold higher risk of primary failure[23]. Our results also showed that higher weight and BMI increased the risk of ET. Obesity-related inflammation and atherosclerosis may promote endothelial injury and reduce blood flow, facilitating thrombosis[14].

We only found 1 study analyzing the relationship between monocytes and primary nAVF failure, and its findings were similar to ours. BojaKoswki et al.[24], reported that monocytes are an independent risk factor for primary failure, and that lower monocyte counts reduce primary failure risk (OR, 0.02; p<0.001). In our study, lower monocyte counts were associated with reduced ET risk. Monocytes play a key role in the coagulation cascade by activating tissue factor, which triggers thrombin generation and thrombus formation[25]; this mechanism may explain the association between monocyte levels and nAVF thrombosis.

Arterial diameter is one of the most extensively studied factors in primary failure[7]. In our study, arterial diameters <2 mm increased the risk of MF. Our findings are consistent with those of Ibeas et al.[9]. Iglesias et al.[8] and the GEMAV guideline[7],

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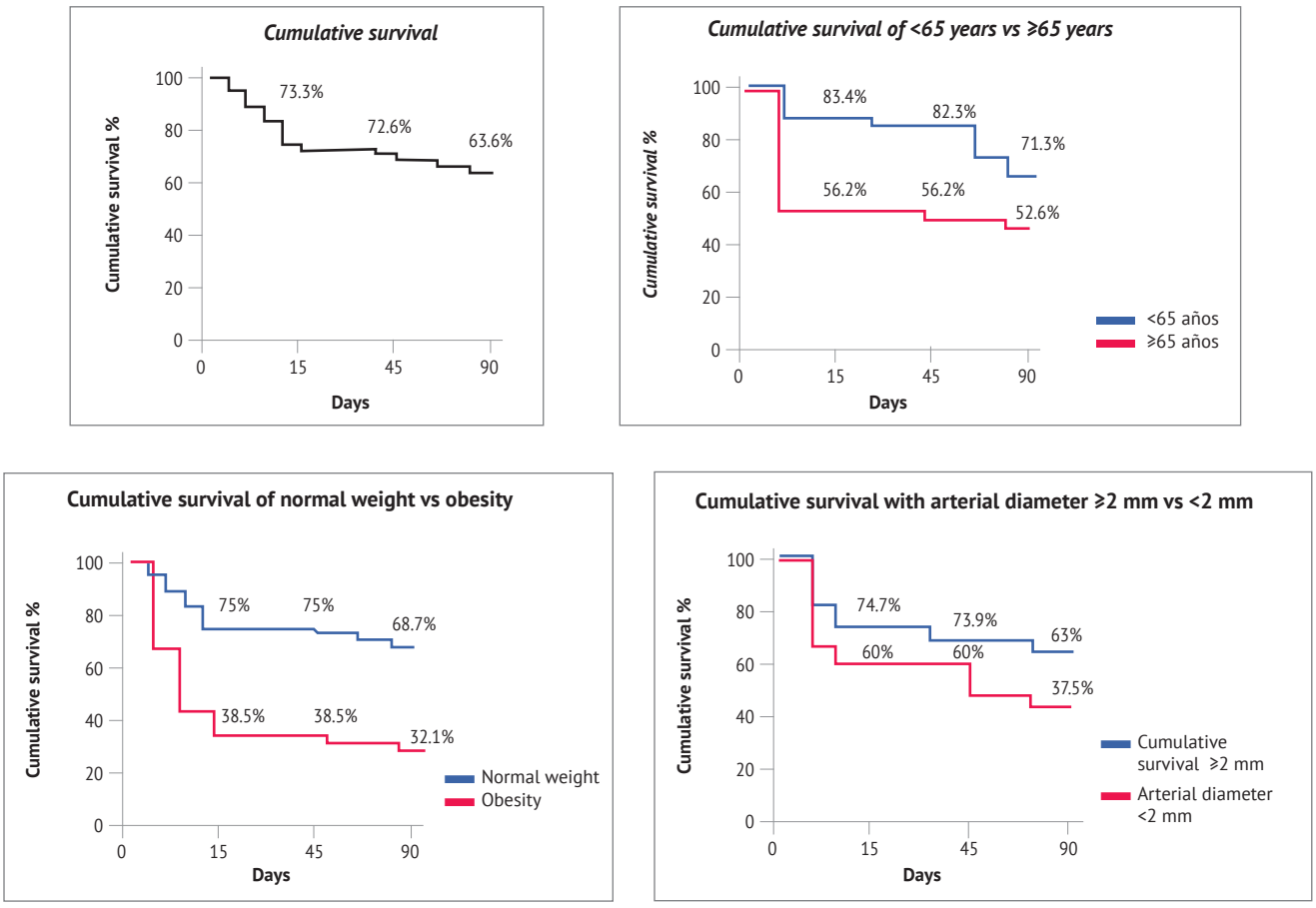

Figure 1. Cumulative survival categorized by age, body mass index, and arterial diameter.

all of which indicate that arterial diameters <2 mm negatively impact nAVF maturation.

We found no literature reporting cumulative nAVF survival within the first three months of maturation. Only Mateos-Torres et al.[18] reported cumulative survival at one month, while most other studies report survival at 6 months, 1 year, or 2 years[11,14]. Mateos-Torres et al.[18] found a 97.5% cumulative survival at one month—much higher than ours at 45 days—although they excluded nAVFs created with arterial diameters <2 mm. However, several studies describe factors affecting nAVF survival, and consistent with our results, patients ≥65 years[3,4,15], individuals with obesity[3,11,14], and those whose nAVFs were created with arterial diameters <2 mm[7] have reduced survival.

The main ultrasound differences between mature nAVFs and those with MF were vein diameter, QA, and brachial-artery PSV. These findings are consistent with Muray-Cases et al.[11], who reported significantly higher venous diameters and QA in mature nAVFs, although they did not measure PSV.

The main limitation of this study is methodological: the sample size was small, resulting in wider confidence intervals and therefore less precise estimates.

Based on our results, the risk factors associated with primary failure were arterial diameters <2 mm, elevated weight and BMI, monocyte levels, and age ≥65 years. Regarding MF and ET specifically, arterial diameters <2 mm increased MF risk, whereas older age, higher weight, and higher BMI increased ET risk. Conversely, lower monocyte counts reduced the risk of ET.

Cumulative survival was lower in patients ≥65 years, in those with arterial diameters <2 mm, and in individuals with obesity. Mature nAVFs consistently showed higher brachial-artery PSV, QA, and venous diameter at all ultrasound assessments compared with nAVFs with MF.

Conflicts of interest

None declared.

Funding

None declared.

Tabla 4. FAVn maduras vs FAVn con fallos de maduración: Mediciones ecográficas a los 15, 45 y 90 días de maduración.

Ultrasound Measurement	Mature AVFs (n=39)	AVFs With Maturation Failure (n=13)	U/t	p-value
AVF at 15 days of maturation				
Anastomosis diameter	3 (IQR. 1.4–4.9)	2.8 (IQR. 1.2–3.2)	208	0.3401
Anastomosis PSV	354 (IQR. 92–425)	280 (IQR. 28–439)	198	0.611
Anastomosis RI	0.44±0.09	0.5±0.12	–1.8	0.0752
Vein diameter	5.35±1.43	4.1±1.17	2.8	<0.0012
QA (flow)	713 (IQR. 230–1784)	362 (IQR. 180–600)	63.5	<0.0011
Humeral artery PSV	96.07±35.6	61.5±25.7	3.2	<0.0012
Humeral artery RI	0.58 (IQR. 0.37–0.72)	0.64 (IQR. 0.7–0.87)	216	0.431
AVF at 45 days of maturation				
Anastomosis diameter	3.2 (IQR. 2–6.7)	3 (IQR. 1.7–4.8)	203	0.61
Anastomosis PSV	325 (IQR. 58–500)	349 (IQR. 102–421)	195	0.8661
Anastomosis RI	0.458±0.09	0.48±0.11	–0.74	0.4622
Vein diameter	6.12±1.5	4.1±1.1	4.2	<0.0012
QA (flow)	912 (IQR. 125–2250)	326 (IQR. 100–415)	38.5	<0.0011
Humeral artery PSV	97 (IQR. 37–243)	53 (IQR. 27–127)	83.5	<0.0011
Humeral artery RI	0.55±0.07	0.62±0.09	–2.7	0.482
AVF at 90 days of maturation				
Anastomosis diameter	3.3 (IQR. 2.2–4.5)	3 (IQR. 1.7–4.2)	188	0.161
Anastomosis PSV	341.4±86.1	221.3±108.3	4.1	<0.0012
Anastomosis RI	0.46±0.07	0.52±0.14	–1.9	0.582
Vein diameter	6.3 (IQR. 5.1–9.8)	4.5 (IQR. 3–6.8)	52.5	<0.0011
QA (flow)	1091.48±378	321.9±126.1	7.1	<0.0012
Humeral artery PSV	95 (IQR. 53–225)	52 (IQR. 33–80)	45	<0.0011
Humeral artery RI	0.59 (IQR. 0.42–0.5)	0.64 (IQR. 0.46–0.88)	102	0.431

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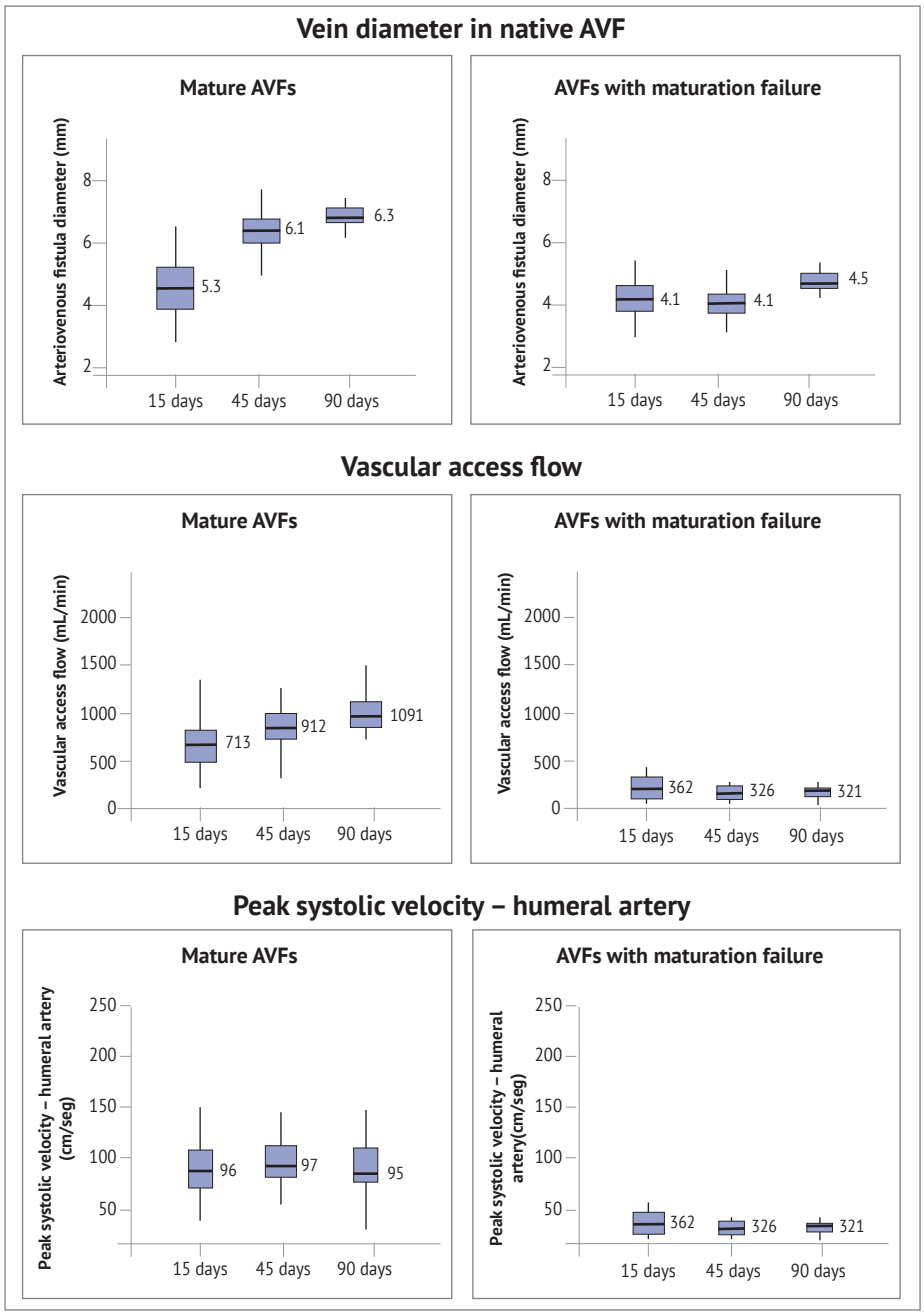

Figure 2. Mature AVFs vs AVFs With Maturation Failure: Main Ultrasound Differences.

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