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The Correlation Between Arterial and Venous Diameters in Chronic Kidney Failure Patients and the Success of Functional Maturation of the Brachiocephalic AV Fistula in Patients with and Without Diabetes Mellitus

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ABSTRACT

Various factors influence the success of arteriovenous fistula (AVF) creation, including vascular anatomical conditions, intraoperative hemodynamics, comorbidities, and arterial and venous diameters. In patients with diabetes mellitus (DM), vascular changes such as venous intimal hyperplasia and arterial atherosclerosis play a crucial role in determining AVF functional maturity. This study aims to analyze the correlation between arterial and venous diameters and the success of AVF functional maturity in patients with chronic kidney failure, both with and without diabetes mellitus. This study employed a retrospective cohort design conducted at the vascular surgery department of RSCM, with data collected retrospectively from 2022 to 2025. Data analysis began with normality testing using the Kolmogorov-Smirnov or Shapiro-Wilk test. Descriptive statistics were used to present demographic and clinical characteristics. Bivariate analysis was performed using Pearson or Spearman correlation tests depending on data distribution. Arterial and venous diameters significantly influenced AVF functional maturity ($p < 0.05$). Patients with mature AVFs had larger arterial diameters (median 3.8 mm) compared to immature AVFs (3.5 mm), and significantly larger venous diameters (2.8 mm vs 2.15 mm). In DM patients, arterial diameter did not significantly affect AVF maturity ($p > 0.05$), whereas venous diameter showed a significant effect ($p < 0.05$). A strong negative correlation was observed between vein diameter and immature AVF incidence ($r = -0.708$; $p < 0.05$). Venous diameter is a significant determinant of AVF functional maturity, particularly in patients with diabetes mellitus, while arterial diameter shows limited influence in this group.

INTRODUCTION

Disease Kidney Chronic (PGK) is one of the global problems are increasing along with increase age population and increasing incidence disease metabolic such as diabetes mellitus and hypertension (Alfano et al., 2022; Borg et al., 2023; Kovesdy, 2022; Patel et al., 2023; Romagnani et al., 2025; Xie et al., 2025). Based on data from the CDC, approximately 15% of the population adults in the United States experiencing PGK, but part big No realize it (Bragg-Gresham et al., 2025; Grobman et al., 2025; Kramarow, 2024). Condition this is very worrying considering that PGK has journey a progressive and often incurable disease symptom to an

advanced stage (Lanini et al., 2022). Therefore that, therapy replacement kidney becomes the only one choice for maintain life.

Diabetes mellitus, in particular type 2, become reason PGK mainstay in various parts of the world. Nephropathy diabetic is one of the complications the most common microvascular found in diabetic patients, with prevalence around 20–40%. Hyperglycemia chronic that is not controlled can cause damage microvascular in the glomerulus, leading to a decrease function filtration and finally going to fail kidney stage end. Patient with the combination of diabetes and CKD has risk higher morbidity and mortality high, especially consequence complications accompanying cardiovascular disease (Alam & Aijaz, 2024; Jyotsna et al., 2023; Ruhe et al., 2023; Schunk & Zimmermann, 2025; Swamy et al., 2023; Warrens et al., 2022).

In the ESRD stage, hemodialysis be one of choice therapy replacement the most common kidney disease (Busink et al., 2023; Fidan & Ağırbaş, 2023; Kim et al., 2023; Zhang & Yuan, 2023). Success hemodialysis is highly dependent on access adequate and functioning vasculature good. Arteriovenous fistula (AVF) is recommended as access vascular First Because level its high patency and risk low infection compared to with graft or central venous catheter. However, it does not all arteriovenous fistulas succeed ripe and can used in a way effective. Failure AVF maturation still become challenge main in practice clinical, which can extend the period of use catheter temporary and improve risk complications.

Previous studies have shown that the success of AVF maturation is influenced by various factors, including arterial and venous diameters, hemodynamic conditions, and comorbidities. Studies by Meyer et al. (2020) and Gasparin et al. (2023) emphasize that vascular diameter is an important predictor of AVF success. Furthermore, research by MacRae et al. indicates that vascular function is closely associated with AVF outcomes. However, most of these studies are general in nature and have not specifically differentiated the impact of vascular diameter between patients with and without diabetes mellitus.

Despite the growing body of literature, there remains a research gap regarding comparative analyses between diabetic and non-diabetic patients in terms of the relationship between arterial and venous diameters and functional AVF maturation. In addition, limited studies have explored the strength of correlation between vascular diameter and AVF maturation failure in depth, particularly within clinical populations in Indonesia. This gap highlights the need for more specific and context-based research.

The urgency of this study lies in the high rate of AVF maturation failure, which leads to increased reliance on central venous catheters that carry higher risks of complications such as infection and thrombosis. A deeper understanding of determinants such as arterial and venous diameters, especially in patients with diabetes mellitus, is essential to improve AVF success rates and enhance the quality of life of CKD patients.

The novelty of this study lies in its analytical approach, which directly compares the relationship between arterial and venous diameters and AVF maturation success in two patient groups, namely those with and without diabetes mellitus, while also quantitatively assessing the strength of these correlations. In addition, this study provides added value by identifying a clinically relevant cut-off value for venous diameter to support successful AVF maturation.

The objective of this study is to analyze the relationship between arterial and venous diameters and the success of functional AVF maturation in CKD patients, as well as to compare these effects between patients with and without diabetes mellitus. The findings of this study

are expected to contribute to the scientific development of nephrology and vascular surgery, and to serve as a clinical reference in planning AVF procedures in order to improve haemodialysis outcomes and reduce complication rates.

METHOD

This study employed a retrospective cohort design to examine the relationship between arterial and venous diameters and the success of functional maturation of arteriovenous fistula (AVF) in patients with chronic kidney disease. The population of this study consisted of all patients diagnosed with chronic kidney failure who underwent brachiocephalic AV fistula creation at the vascular surgery department of RSCM between 2022 and 2025. The sample was selected using a total sampling technique, in which all eligible patients who met the inclusion criteria such as complete medical records, documented vascular measurements, and follow-up data on AVF maturation were included. Patients with incomplete data or prior vascular access procedures were excluded to ensure data consistency and accuracy.

The research instrument used in this study was a structured data extraction form designed to collect relevant variables from medical records, including demographic characteristics, comorbidities (such as diabetes mellitus, hypertension, and dyslipidemia), arterial and venous diameters, and AVF maturation outcomes. To ensure validity, the instrument was developed based on established clinical guidelines and relevant literature, and its content validity was reviewed by clinical experts in nephrology and vascular surgery. Reliability was ensured through repeated data extraction by independent reviewers, and inter-rater agreement was assessed to maintain consistency. Data collection was conducted retrospectively by reviewing patient records and hospital databases following ethical approval and institutional permission.

The data collection procedure involved identifying eligible patients, extracting required variables, and coding the data into a standardized database. Statistical analysis was performed using software such as IBM SPSS Statistics version 25. Descriptive statistics were used to summarize demographic and clinical characteristics. Normality tests (Kolmogorov-Smirnov or Shapiro-Wilk) were conducted to determine data distribution. Bivariate analysis was performed using Pearson or Spearman correlation tests to assess the relationship between arterial and venous diameters and AVF maturation, while comparisons between groups were analyzed using independent t-tests or Mann-Whitney U tests. A significance level of $p < 0.05$ was considered statistically significant.

RESULT AND DISCUSSION

Characteristics of Research Samples

Table 1. Characteristics clinical

Variables	Mark
Number of samples	
Age, median (RIK)	53.5 (20.5)
Gender, n (%)	
Woman	34 (42.5)
Man	46 (57.5)
Smoking, n (%)	37 (46.3)
Diabetes mellitus, n (%)	40 (50.0)

Hypertension, n (%)	79 (98.8)
Dyslipidemia, n (%)	61 (76.3)
Arterial diameter, median (RIK)	3.82 (5.0)
Median vein diameter (RIC)	2.52(5.0)
AVF maturity, n (%)	
Matur	62 (77.5)
Not mature	18 (22.5)

Source: Primary data from medical records of CKD patients undergoing AVF at RSCM, 2022–2025

Based on Table1, it is obtained that the median age subject study is 53.5 years, with part big subject study various sex male (57.5%), smoking (46.3%), diabetes mellitus (50%), hypertension (98.8%), dyslipidemia (76.3%), median artery diameter 3.82 mm, and median vein diameter 2.52 mm. In this study here, there is mature AVF findings as many as 77.5%, or 62 subjects.

Table 2. Relationship Clinical Characteristics with AVF Maturity

Variables	AVF Maturity		p-value
	Matur	Not mature	
Average age ± SB	47.72 ± 15.61	60.33 ± 8.85	0,000*
Gender, n (%)			
Woman	27 (43.5)	7 (38.9)	0.725
Man	35 (56.5)	11 (61.1)	
Smoking, n (%)	27 (43.5)	10 (55.6)	0.368
Diabetes mellitus, n (%)	24 (38.7)	16 (88.9)	0,000*
Hypertension, n (%)	61 (98.4)	18 (100)	1,000
Dyslipidemia, n (%)	46 (74.2)	15 (83.3)	0.422

Source: Primary data from clinical characteristics analysis of CKD patients at RSCM, 2022–2025

Based on Table 2, it was carried out analysis bivariate about connection characteristics clinical, including age, type gender, history smoke history of diabetes mellitus, history hypertension, and history dyslipidemia, with AVF maturity. Based on analysis bivariate, obtained only age and diabetes mellitus only those who have proportion with difference significant between patient with mature and non-mature AVF mature ($p < 0.05$). 4.3 Relationship between Arterial and Vein Diameter with AVF maturity.

Table 3. Relationship between Arterial Diameter and Veins with AVF Maturity

Variables	AVF Maturity		p-value
	Matur	Not mature	
Arterial diameter, median (RIK)	3.8 (0.6)	3.50 (0.43)	0.002*
Median vein diameter (RIC)	2.8 (0.4)	2.15 (0.58)	0,000*

Source: Primary data from measurements of arterial and venous diameters of CKD patients at RSCM, 2022–2025

Based on Table 3, it was found that the diameter of the arteries and veins had an effect significant to AVF maturity ($p < 0.05$). Patients with mature AVF have a median artery

diameter larger, namely 3.8 mm, compared to those that are not mature, namely 3.5 mm, and patient with mature AVF have a larger vein diameter big in a way significant, namely 2.8 mm, compared to those who did not mature, namely 2.15 mm. In clinical, patient with veins or arteries smaller risky more tall experiencing AVF not mature.

Table 4. Correlation Level of Arterial Diameter and Veins with Immature AVF

Variables	Immature AVF event	
	r value	p-value
Artery diameter	-0.346	0.002*
Vein diameter	-0.656	0,000*

Source: Primary data from correlation analysis between vascular diameter and immature AVF incidence at RSCM, 2022–2025

Based on Table 4, there are connection significant and negative between the diameter of arteries and veins with AVF incidents do not occur mature ($p < 0.05$). Arterial diameter show correlation negative weak to AVF incidents do not occur mature ($r = -0.346$), while the vein diameter indicates correlation negative strong to AVF incidents do not occur mature ($r = -0.656$). 4.4 Relationship between arterial and venous diameters with AVF maturity in DM patients.

Table 5. Relationship between Artery and Vein Diameter with AVF Maturity in DM Patients

Variables	AVF Maturity in DM Patients		p-value
	Matur	Immature	
Arterial diameter, median (RIK)	3.7 (0.70)	3.50 (0.43)	0.107
Median vein diameter (RIC)	2.7 (0.48)	2.15 (0.10)	0,000*

Source: Primary data from the diabetes mellitus subgroup at RSCM, 2022–2025

Based on Table 5, the diameter of the artery is obtained No influential significant to AVF maturity in DM patients ($p > 0.05$). Meanwhile that, the diameter of the vein has an effect significant to AVF maturity in DM patients ($p < 0.05$). Patients with mature AVF have a larger vein diameter big in a way significant, namely 2.70 mm, compared to those who did not mature, namely 2.15 mm.

Table 6. Correlation Level of Arterial and Vein Diameters with Immature AVF in DM Patients

Variables	The incidence of immature AVF in DM patients	
	r value	p-value
Artery diameter	-0.260	0.106
Vein diameter	-0.708	0,000*

Source: Primary data from correlation analysis of vascular diameter in diabetes mellitus patients at RSCM, 2022–2025

Based on Table 6., there are connection significant and negative between the veins and AVF incidents do not occur mature in DM patients ($p < 0.05$). The diameter of the veins

indicates correlation negative strong to AVF incidents do not occur mature (r = -0.708). 4.4 Relationship between arterial and venous diameters with AVF maturation in non-DM patients.

Table 7. Relationship between Artery and Vein Diameters with AVF Maturity in Non-DM Patients

Variables	AVF Maturity in Non-DM Patients		p-value
	Matur	Immature	
Arterial diameter, median (RIK)	3.90 (0.40)	3.40	0.108
Median vein diameter (RIC)	2.80 (0.33)	2.15	0.003*

Source: Primary data from the non-diabetes mellitus subgroup at RSCM, 2022–2025

Based on Table 7., the diameter of the artery is obtained No influential significant to AVF maturity in non-DM patients (p >0.05). Meanwhile that, the diameter of the vein has an effect significant to AVF maturity in non-DM patients (p <0.05). Patients with mature AVF have a larger vein diameter big in a way significant, namely 2.80 mm, compared to those who did not mature, namely 2.15 mm.

Table 8. Correlation Level of Artery and Vein Diameter with Immature AVF in non-DM Patients

Variables	The incidence of immature AVF in non-DM patients	
	r value	p-value
Artery diameter	-0.267	0.096
Vein diameter	-0.381	0.015*

Source: Primary data from correlation analysis of vascular diameter in non-diabetes mellitus patients at RSCM, 2022–2025

Based on Table 8., there are connection significant and negative between the veins and AVF incidents do not occur mature in non-DM patients (p <0.05). The diameter of the veins indicates correlation negative weak to AVF incidents do not occur mature (r = -0.381).

CONCLUSION

Patient with mature AVF have a median artery diameter larger, namely 3.8 mm, compared to those that are not mature, namely 3.5 mm, and patient with mature AVF have a larger vein diameter big in a way significant, namely 2.8 mm, compared to those who did not mature, namely 2.15 mm. In clinical, patient with veins or arteries smaller risky more tall experiencing AVF not mature. Artery diameter No influential significant to AVF maturity in DM patients While that, the diameter of the vein has an effect significant to AVF maturity in DM patients. Patients with mature AVF have a larger vein diameter big in a way significant, namely 2.70 mm, compared to those who did not mature, namely 2.15 mm. Patient with DM disease status and age Continued to be very influential for success something AVF Maturity. Cut Off Vein diameter for Success A maturity Functional in study this is 2.7 mm where in the literature That the minimum vein diameter is 2.5 mm.

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