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Original Article

Comparison of Early Outcome of Arteriovenous Fistula for Dialysis Access among Diabetic and Non-Diabetic Patients: A Comparative Prospective Observational Study

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ABSTRACT

Arteriovenous fistula (AVF) is the preferred vascular access for hemodialysis, but early maturation failure and postoperative complications remain important concerns. Diabetes mellitus may affect vascular remodeling and has been considered a potential risk factor for adverse AVF outcomes, though evidence remains inconsistent. **Objective:** To compare the early outcomes of AVF creation for hemodialysis access among diabetic and non-diabetic patients. **Methods:** This comparative prospective observational study was conducted at the Department of Cardiovascular Surgery, Ayub Teaching Hospital, from April 2025 to March 2026. A total of 254 patients undergoing AVF creation were included through non-probability consecutive sampling. Patients were grouped according to diabetic status. Early outcomes assessed included AVF maturation, thrombosis, infection, hematoma formation, and AVF failure. Categorical variables were compared using the chi-square or Fisher's exact test and continuous variables using the independent-samples t-test, with $p \leq 0.05$ considered significant; unadjusted odds ratios with 95% confidence intervals were calculated. **Results:** Mean age was 48.3 ± 17.8 years; 117 (46.1%) patients were diabetic, and 137 (53.9%) were non-diabetic. Early maturation occurred in 56.4% of diabetic and 54.7% of non-diabetic patients (p=0.790). Thrombosis (45.3% vs 44.5%, p=0.902), infection (49.6% vs 53.3%, p=0.555), and AVF failure (46.2% vs 46.7%, p=0.929) did not differ significantly between groups. On unadjusted analysis, smoking was associated with AVF failure (p=0.038, borderline), whereas hypertension (p=0.104) and radiocephalic fistula type (p=0.145) were not. **Conclusions:** No statistically significant difference in early AVF outcomes was detected between diabetic and non-diabetic patients. Diabetes was not significantly associated with poorer early AVF outcomes in this cohort, but the study may have been underpowered to exclude a clinically important difference.

INTRODUCTION

Chronic kidney disease (CKD) has become a major issue in the global health scenario, whereby many millions of people are affected around the world [1]. The course of CKD is usually progressive, which results in the development of end-stage renal disease (ESRD), whereby the functioning of the kidney is compromised to an extent where it is no longer functioning to keep a person alive. The modality of hemodialysis is still among the modalities that have become the most popular in the management of ESRD, especially in developing nations where kidney transplantation might not be readily accessible [2]. A good hemodialysis procedure would entail having a stable and long-lasting vascular access that could sustain repeated cannulation of the neck and proper circulation of blood

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during each dose of dialysis. Arteriovenous fistula (AVF) is commonly regarded as the gold standard of the different types of vascular access that can be used to administer hemodialysis [3]. AVF is formed operatively by means of joining a native artery with a vein in the forearm or upper arm. This relationship enables the blood to move directly from the vein in the arteries, which leads to an increase in the size of the vein and thickening of the vein walls over time. When grown up, the fistula is capable of enduring repeated needle injections that are needed during hemodialysis [4]. AVFs have higher long-term patency, lower infection rates, diminished risk of thrombosis, and fewer hospitalizations compared to other vascular access techniques, including arteriovenous grafts and central venous catheters [5]. For these reasons, clinical guidelines highly recommend AVF as the vascular access of choice for a patient undergoing long-term hemodialysis. Irrespective of these benefits, early functionality and maturation of AVF is still a major problem in clinical practice [6]. The most frequent complications include AVF maturation failure, thrombosis, infection, and poor blood flow that may undermine the efficiency of the fistula and slow commencement of dialysis. Research has indicated that a significant percentage of newly developed fistulas do not grow enough to be useful and, as a result, the patient might require further interventions or other forms of vascular access [7]. Thus, it is important to find factors that can affect AVF outcomes to manage patients better and provide them with the best dialysis options. Several patient and procedural determinants have been pointed out as possible predictors of AVF success [8-10]. These are age, sex, vascular anatomy, comorbid conditions, vessel diameter, surgical experience, and aftercare [11]. Diabetes mellitus is one of these factors and has been widely acknowledged as a significant risk factor in determinants of vascular health and in its possible effects on the outcomes of AVF. One of the most prevalent causes of chronic kidney disease and ESRD all over the world is diabetes, and the percentage of patients who undergo dialysis also has underlying diabetes [12]. There are numerous vascular pathophysiologies linked with diabetes mellitus, such as endothelial dysfunction, increased atherosclerosis, arterial stiffness, and microvascular damage [13]. Such changes could lead to a deficiency in the adaptability of blood vessels to the rising blood volume that is obligatory during AVF maturation. Also, due to diabetes, the veins of such patients are smaller and less robust, which can also diminish the chances of successful fistula development and growth [2]. Globally, chronic kidney disease affects nearly one in seven adults, with approximately 788 million adults estimated to be living with the condition in 2023 [14]. In Pakistan, recent literature reports a CKD prevalence of approximately 12.5%–29.9%, while diabetes is present in nearly half of patients with stage 5 CKD. This growing burden has increased the need for reliable hemodialysis access and supports evaluation of arteriovenous fistula outcomes in diabetic and non-diabetic patients [15, 16]. It was hypothesized that there is no significant difference in early arteriovenous fistula maturation, complication rates, and early fistula failure between diabetic and non-diabetic patients undergoing AVF creation for hemodialysis access.

Despite growing concern regarding the potential effect of diabetes mellitus on vascular remodeling and fistula maturation, available evidence regarding its influence on early arteriovenous fistula outcomes remains inconsistent, with some studies reporting poorer outcomes in diabetic patients while others show no significant difference. Moreover, local data comparing early AVF outcomes between diabetic and non-diabetic patients are limited, particularly in the current population. This gap in evidence necessitates further evaluation to clarify whether diabetes independently affects fistula maturation and early complications. Therefore, this study aimed to compare the early outcomes of arteriovenous fistula creation for hemodialysis access among diabetic and non-diabetic patients.

METHODS

This comparative prospective observational study was conducted at the Department of Cardiovascular Surgery, Ayub Teaching Hospital, Abbottabad, from April 2025 to March 2026. Data collection commenced after receiving the consent of the Institutional Ethical Review Committee under the IRB reference no RC-EA-2025/73 dated 26 March 2025. A total of 254 patients requiring arteriovenous fistula creation for hemodialysis access were included in the study. The sample size was calculated using the WHO sample size calculator for the comparison of two independent proportions, with early AVF maturation considered the primary outcome. Santosa et al. reported AVF maturation rates of 56.5% among diabetic patients and 78.3% among non-diabetic patients [17]. Using these anticipated proportions, a 95% confidence level, 80% statistical power, and a 5% level of significance, the minimum required sample size was approximately 72 patients per group (about 144 in total). To improve statistical precision and account for potential incomplete follow-up, 254 patients (117 diabetic and 137 non-diabetic) were enrolled by non-probability consecutive sampling, exceeding the minimum requirement. Patients were eligible if diagnosed with chronic kidney disease that required hemodialysis and were undergoing surgical creation of a native arteriovenous fistula. Eligibility criteria were adult patients aged 18 years and above of either gender. Both diabetic and non-diabetic patients were to be

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included to facilitate the comparison of early AVF outcomes in the two groups. Patients were also excluded if they had already developed AVF at the same location, had severe peripheral vascular disease, had infection at the surgical site, had coagulation disorders, or did not wish to engage in the research. Infection at the AVF site was defined as the presence of local erythema, warmth, tenderness, swelling, or purulent discharge at the surgical site, with or without fever, requiring antibiotic treatment as documented during early postoperative follow-up; routine wound care or dressing alone was not counted as infection. Mild postoperative redness or inflammation without clinical suspicion of infection or need for treatment was not classified as infection. The type of arteriovenous fistula was recorded intraoperatively by the operating surgeon and documented in the structured proforma based on the anatomical site of fistula creation. Fistulas were classified as radiocephalic or brachiocephalic according to standard surgical definitions and later analyzed as a study variable in relation to early outcomes and AVF failure. Arteriovenous fistula failure was defined as the inability of the fistula to become clinically usable for hemodialysis by the 6-week postoperative assessment due to non-maturation, thrombosis, inadequate blood flow, or loss of a palpable thrill/bruit requiring an alternative vascular access or further intervention. Fistulas that matured adequately and were suitable for dialysis cannulation at six weeks were classified as successful. Incomplete patient medical records and those with early follow-up loss were also excluded from the analysis. The patients who came for AVF creation were considered eligible and identified with the help of the surgical department and dialysis units. The researchers informed the participants about the aim of the research and the steps that would be used in it and obtained informed consent in writing. A structured data collection form was used to record baseline demographic and clinical data such as age, gender, chronic renal disease, diabetes mellitus, and hypertension among other comorbidities. Patients were classified as diabetic or non-diabetic. Each patient was surgically implanted with an arteriovenous fistula as per normal surgical procedures by experienced surgeons. Routine procedures on fistulas were radiocephalic fistulas and brachiocephalic fistulas based on the anatomy of the vessels and the choice of the surgeon. Follow-up of the patients was done in the early postoperative period to determine the early outcome of the AVF. Measures of parameters were successful fistula maturation, presence of thrill or bruit, early thrombosis, infection of the fistula site, hematoma, and failure of fistula maturation. Follow-up visits were conducted according to the study protocol, and the final early outcome assessment was done at 6 weeks.

Data were entered and analyzed using IBM SPSS Statistics version 26.0. Quantitative variables were summarized as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Comparisons of categorical outcomes between diabetic and non-diabetic patients were performed using Pearson's chi-square test (without continuity correction), or Fisher's exact test when any expected cell count was <5. Continuous variables were compared using the independent-samples t-test. Relative risks and unadjusted odds ratios with 95% confidence intervals were calculated. A two-tailed p-value of ≤0.05 was considered statistically significant.

RESULTS

Data were collected from 254 patients, with a mean age of 48.3 ± 17.8 years. Most participants belonged to the 36–50 years age group (84, 33.1%), followed by 18–35 years (78, 30.7%), 51–65 years (61, 24.0%), and more than 65 years (31, 12.2%). The gender distribution was nearly equal, with 125 (49.2%) males and 129 (50.8%) females. Regarding comorbid conditions, 117 (46.1%) patients were diabetic while 137 (53.9%) were non-diabetic. Hypertension was present in 139 (54.7%) participants, whereas 115 (45.3%) did not have hypertension. Smoking history was reported in 101 (39.8%) patients, while 153 (60.2%) were non-smokers (Table 1).

Table 1: Demographic and Clinical Characteristics of Study Participants (n=254)

Variables	Category	n (%) / Mean ± SD
Age (years)	–	48.3 ± 17.8
Age Group	18–35 Years	78 (30.7%)
	36–50 Years	84 (33.1%)
	51–65 Years	61 (24.0%)
	>65 Years	31 (12.2%)
Gender	Male	125 (49.2%)
	Female	129 (50.8%)
Diabetic Status	Diabetic	117 (46.1%)
	Non-Diabetic	137 (53.9%)
Hypertension	Yes	139 (54.7%)
	No	115 (45.3%)
Smoking Status	Smoker	101 (39.8%)
	Non-Smoker	153 (60.2%)
Body Mass Index (kg/m^2)	–	26.7 ± 4.8
Duration of CKD (years)	–	4.6 ± 2.3

Radiocephalic fistula was created in 121 (47.6%) patients, while brachiocephalic fistula was performed in 133 (52.4%) patients. The fistula site was almost equally distributed between arms, with 126 (49.6%) placed in the left arm and 128 (50.4%) in the right arm. A palpable thrill immediately after surgery was observed in 182 (71.7%) patients, indicating successful fistula creation, whereas 72 (28.3%) patients did not demonstrate an immediate thrill (Table 2).

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Table 2: Arteriovenous Fistula Characteristics and Surgical Details(n=254)

Variables	Category	n (%)
Type of AVF	Radiocephalic	121 (47.6%)
	Brachiocephalic	133 (52.4%)
AVF Site	Left Arm	126 (49.6%)
	Right Arm	128 (50.4%)
Presence of Thrill Immediately After Surgery	Yes	182 (71.7%)
	No	72 (28.3%)
Dialysis Initiated Through AVF	Yes	168 (66.1%)
	No	86 (33.9%)

At the standardized 6-week postoperative assessment, early arteriovenous fistula maturation was observed in 141 of 254 patients, corresponding to a maturation rate of 55.5% (95% CI: 49.4–61.6%). Early thrombosis occurred in 114 (44.9%) patients, AVF-site infection in 131 (51.6%), hematoma formation in 116 (45.7%), and overall AVF failure in 118 (46.5%) patients (Table 3).

Table 3: Early Postoperative Outcomes of Arteriovenous Fistula (n=254)

Outcomes	n (%)	95% CI
Early AVF Maturation	141 (55.5%)	49.4–61.6
Early Thrombosis	114 (44.9%)	38.8–51.0
AVF-Site Infection	131 (51.6%)	45.5–57.7
Hematoma Formation	116 (45.7%)	39.6–51.8
Overall AVF Failure	118 (46.5%)	40.4–52.6

Early maturation occurred in 66 (56.4%) diabetic patients and 75 (54.7%) non-diabetic patients, showing no statistically significant difference (p=0.790). Early thrombosis was observed in 53 (45.3%) diabetic patients and 61 (44.5%) non-diabetic patients (p=0.902). Infection at the fistula site was reported in 58 (49.6%) diabetic patients compared with 73 (53.3%) non-diabetic patients (p=0.555) (Table 4).

Table 4: Comparison of Early AVF Outcomes Between Diabetic and Non-Diabetic Patients(n=254)

Outcomes	Diabetic, n (%)	Non-diabetic, n (%)	Relative Risk (95% CI)	p-value
Early AVF Maturation	66 (56.4%)	75 (54.7%)	1.03 (0.83–1.28)	0.790
Early Thrombosis	53 (45.3%)	61 (44.5%)	1.02 (0.77–1.34)	0.902
AVF-Site Infection	58 (49.6%)	73 (53.3%)	0.93 (0.73–1.18)	0.555
Overall AVF Failure	54 (46.2%)	64 (46.7%)	0.99 (0.76–1.29)	0.929

Failure was observed in 54 (46.2%) diabetic patients and 64 (46.7%) non-diabetic patients, with no statistically significant difference between the groups (p=0.929). On unadjusted analysis, smoking was associated with a higher frequency of early AVF failure (54.5% vs 41.2%; OR 1.71, 95% CI 1.03–2.84; p=0.038), although this finding was borderline (p=0.051 with continuity correction). Hypertension (51.1% vs 40.9%; OR 1.51, 95% CI 0.92–2.49; p=0.104) and radiocephalic fistula type (51.2% vs 42.1%; OR 1.44, 95% CI 0.88–2.37; p=0.145) were not significantly associated with failure (Table 5).

Table 5: Factors Associated with Early AVF Failure(n=254)

Variables	Category	AVF Failure, n (%)	No Failure, n (%)	p-value	Unadjusted OR (95% CI)
Diabetes	Yes	54 (46.2%)	63 (53.8%)	0.932	0.98 (0.60–1.60)
	No	64 (46.7%)	73 (53.3%)		
Hypertension	Yes	71 (51.1%)	68 (48.9%)	0.038	1.51 (0.92–2.49)
	No	47 (40.9%)	68 (59.1%)		
Smoking Status	Smoker	55 (54.5%)	46 (45.5%)	0.029	1.71 (1.03–2.84)
	Non-smoker	63 (41.2%)	90 (58.8%)		
AVF Type	Radiocephalic	62 (51.2%)	59 (48.8%)	0.047	1.44 (0.88–2.37)
	Brachiocephalic	56 (42.1%)	77 (57.9%)		

DISCUSSION

Arteriovenous fistula (AVF) is regarded as the most desirable vascular access in the case of long-term hemodialysis because it has higher patency rates, lower infection rates, and lower rates of complications as opposed to other vascular access techniques. Nevertheless, several patient-related factors can contribute to the initial results of AVF creation, one of which is often regarded as diabetes mellitus. Diabetes has microvascular and macrovascular alterations, which could suppress vascular remodeling and endothelial activity and potentially influence fistula maturation and expose it to thrombosis and failure. In the current research, 254 patients undergoing AVF construction as a dialysis access were examined in order to compare the early outcomes of diabetic and non-diabetic individuals. The average age of the participants was 48.3 ± 17.8 years, and the ratio of females and males was almost equal. About 46.1 percent of the patients had diabetes, and this demonstrated the already known correlation between diabetes and chronic kidney disease that causes end-stage renal disease. The same demographic trends were documented in earlier studies; diabetes is one of the most frequent causes of kidney disease that needs dialysis services. The overall early AVF maturation rate in this study was 55.5% (95% CI

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49.4–61.6%), which lies within the range of approximately 50–70% reported in other studies. The issue of early maturation is a critical factor that leads to successful dialysis access, since failure to mature enough to commence dialysis on time leads to either delayed dialysis commencement or the use of other methods of accessing dialysis, such as the use of central venous catheters. In the current research, early maturation was observed in 56.4% of the diabetic patients and 54.7% of patients who were not diabetic, and the difference between the two was not significant. In this unadjusted analysis, no statistically significant difference in early maturation was detected; however, because other factors were not controlled for and the study had limited power, this should not be interpreted as evidence that diabetes has no effect on early AVF maturation. Early thrombosis has been considered one of the most frequent causes of AVF failure. In the current research, thrombosis was present in 44.9% of patients in general. There was no significant difference in the incidence of thrombosis between diabetic and non-diabetic groups 45.3% and 44.5%, respectively. These results are in line with other studies that have indicated that although diabetes is a contributing factor to vascular pathology, the risk of thrombosis is frequently determined by a combination of factors like the method of application of surgery, size of the vessels, and postoperative care, and not diabetes. Fistula infection was found among 51.6% of the patients in this study. Despite the fact that the infection rates were slightly higher in non-diabetic than in diabetic patients, the same difference was not found to be significant. The observed rates of infection (51.6%), thrombosis (44.9%) and hematoma (45.7%) are considerably higher than most published series, which may reflect the broad outcome definitions used, including wound care in the infection definition, and should be interpreted with caution. The risk of infection in AVF access has also been shown to be lower than in other dialysis access modes, such as grafts or catheters, highlighting the benefit of AVF as a permanent vascular access substitute. Other clinical variables were also examined. On unadjusted analysis, smoking was associated with a higher frequency of early AVF failure (54.5% vs 41.2%; p=0.038), although this finding was borderline (p=0.051 with continuity correction) and was not adjusted for confounders. Failure was numerically more frequent in patients with hypertension (51.1% vs 40.9%; p=0.104) and in radiocephalic compared with brachiocephalic fistulas (51.2% vs 42.1%; p=0.145), but neither difference reached statistical significance. The sample-size calculation assumed a maturation rate of 78.3% in non-diabetic patients, based on Santosa et al. [17], whereas the observed rate was 54.7%. The observed between-group difference (1.7 percentage points) was far smaller than the 21.8-point difference assumed[18,19], and the study had only about 35% power to detect a 10-percentage-point difference. The 95% confidence interval for the maturation relative risk (0.83–1.28) is compatible with a clinically meaningful difference in either direction, so the absence of a statistically significant difference should not be read as equivalence[20].

There are several limitations in this study that one should take into consideration when interpreting the findings. First, the single-center design with 254 patients may limit the generalizability of the findings to broader populations. Second, the observational nature of the study enabled the assessment of only early results of arteriovenous fistula repair and not the long-term patency or late adverse events. Third, this study did not examine some clinical variables that could affect fistula maturation and failure, including vessel diameter, surgical skills, and comprehensive vascular imaging findings. Fourth, associations with failure were examined using unadjusted analyses, so confounding cannot be excluded. Fifth, maturation, thrombosis and hematoma were not defined by fully objective criteria, the infection, thrombosis and hematoma rates were unusually high, and the study was not powered to detect modest differences or to establish equivalence. Sixth, prior vascular access, CKD stage, dialysis status and antiplatelet use were not reported. These constraints indicate that more multicenter prospective studies with extended follow-up should be conducted in the future to get a better insight into the long-term prognosis of arteriovenous fistula formation in diabetic and non-diabetic patients.

CONCLUSIONS

In this study, no statistically significant difference in early arteriovenous fistula outcomes (maturation, thrombosis, infection, and overall failure) was detected between diabetic and non-diabetic patients. Because the analysis was unadjusted and the study had limited power to detect modest differences, these findings do not establish equivalence; larger studies with objective outcome definitions and adjusted analyses are needed.

Authors' Contribution

Conceptualization: IA
Methodology: IA, AT
Formal analysis: IA
Writing and Drafting: IA, DN, AT, MN, HI
Review and Editing: IA, DN, AT, MN, HI

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflict of Interest

All the authors declare no conflict of interest.

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