

IMPACT OF DIABETES MELLITUS ON ARTERIOVENOUS FISTULA MATURATION AND PRIMARY PATENCY IN PATIENTS UNDERGOING HEMODIALYSIS

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ABSTRACT

Background

Diabetes mellitus may adversely affect arteriovenous fistula (AVF) maturation and long-term patency in patients receiving maintenance haemodialysis. This study evaluated the association between diabetes and AVF maturation, complications, and patency.

Methods

A single-center observational study was conducted at the Department of Cardiovascular Surgery, Imran Idrees Teaching Hospital, Sialkot, Pakistan. Consecutive eligible patients undergoing native AVF creation between 20 February 2025 and 30 January 2026 were included. Patients were categorized according to diabetes status. Demographic, clinical, vascular, operative and AVF outcome variables were compared. Kaplan–Meier analysis, multivariable logistic regression and Cox proportional-hazards regression were performed.

Results

Among 700 patients, 322 (46.0%) had diabetes and 378 (54.0%) did not. Successful AVF maturation was significantly lower in diabetic patients than non-diabetic patients (61.8% vs. 84.7%, $p < 0.001$), while primary failure was higher (16.5% vs. 5.3%). Diabetic patients had longer time to maturation (63 vs. 44 days) and first successful cannulation (72 vs. 53 days), and more frequently required assisted maturation (34.5% vs. 12.2%; all $p < 0.001$). Thrombosis, stenosis and access-related infection were also significantly more frequent among diabetic patients. Twelve-month primary patency among matured fistulas was 24.5% versus 52.5%, while secondary patency was 58.0% versus 86.6% in diabetic and non-diabetic patients, respectively. Diabetes independently predicted maturation failure (adjusted OR 4.56; 95% CI 2.21–9.44) and loss of primary patency (adjusted HR 2.62; 95% CI 2.02–3.42).

Conclusion

Diabetes mellitus was independently associated with impaired AVF maturation and substantially reduced patency. Diabetic patients may benefit from meticulous vascular assessment, individualized access planning and closer postoperative surveillance.

Keywords:

Diabetes Mellitus; Arteriovenous Fistula; Haemodialysis; Fistula Maturation; Vascular Access; Primary Patency

INTRODUCTION

End-stage kidney disease (ESKD) is an important global health problem, and maintenance hemodialysis remains a major modality of kidney replacement therapy. A reliable vascular access is essential for effective and safe delivery of hemodialysis. Native arteriovenous fistula (AVF) remains an important access option because, when successfully matured and maintained, it generally provides durable dialysis access with fewer infectious complications than central venous catheters. Current vascular-access guidance emphasizes individualized access planning based on the patient's overall kidney-failure life plan, vascular anatomy, comorbidities and anticipated dialysis requirements [1,2].

Despite these advantages, creation of an AVF does not guarantee successful maturation. Following surgical creation, the feeding artery and draining vein must undergo substantial structural and functional remodelling, including increased blood flow, arterial enlargement and venous dilatation. Failure of this adaptive process may result in delayed maturation, primary failure, prolonged catheter dependence and additional surgical or endovascular interventions [3-6]. Contemporary multicenter data indicate that AVF maturation remains suboptimal and that a substantial proportion of fistulas require intervention either to achieve maturation or subsequently maintain functionality [6].

Diabetes mellitus is particularly relevant to AVF outcomes because it is frequently accompanied by hypertension, obesity, dyslipidaemia, cardiovascular disease, peripheral vascular disease and advanced vascular age. Chronic hyperglycemia contributes to endothelial dysfunction, atherosclerosis, medial arterial calcification,

inflammation and impaired vascular compliance, potentially limiting the hemodynamic and remodelling responses required for successful fistula maturation [7-9]. Recent studies have demonstrated an association between diabetes and impaired AVF maturation, while other investigations suggest that the magnitude of this effect may vary according to fistula location, vessel characteristics and patient selection [10-13].

Evidence from South Asia and Pakistan is comparatively limited. Pakistani studies have documented substantial rates of AVF complications and variable patency, while a case-controlled study from Aga Khan University Hospital demonstrated lower short-term patency among diabetic patients undergoing brachiobasilic AVF creation [14-17]. However, large contemporary Pakistani cohorts specifically evaluating diabetes in relation to both maturation and longitudinal primary patency remain scarce. Therefore, this study evaluated the effect of diabetes mellitus on AVF maturation, time to successful cannulation, primary failure, complications and primary and secondary patency among consecutive patients undergoing native AVF creation at the Department of Cardiovascular Surgery, Imran Idrees Teaching Hospital, Sialkot, Pakistan.

METHODOLOGY

Study Design and Setting

A single-center observational cohort study was conducted at the Department of Cardiovascular Surgery, Imran Idrees Teaching Hospital, Sialkot, Pakistan. Consecutive eligible patients undergoing native AVF creation for maintenance hemodialysis between 20 February 2025 and 30

January 2026 were included prospectively. A total of 700 consecutive eligible cases were analyzed.

Study Population

Patients were categorized according to the presence or absence of diabetes mellitus. Diabetes was defined on the basis of an established clinical diagnosis documented in the medical record and/or ongoing glucose-lowering treatment.

Patients undergoing native radiocephalic, brachiocephalic or brachio basilic AVF creation were included. Patients with arteriovenous grafts, previous AVF at the same operative site, documented central venous obstruction affecting the access limb, inadequate outcome follow-up or insufficient information regarding diabetes status or AVF outcome were excluded.

Preoperative and Operative Assessment

Demographic and clinical variables included age, sex, body mass index, duration of hemodialysis, diabetes and duration of diabetes, hypertension, ischemic heart disease, peripheral vascular disease, smoking and dyslipidaemia. Laboratory variables included hemoglobin, serum albumin, creatinine, blood urea, calcium, phosphate and HbA1c where available.

Preoperative vascular assessment included clinical examination and Doppler ultrasonography for assessment of arterial and venous calibre and suitability for AVF creation. AVFs were categorized as radiocephalic, brachiocephalic or brachio basilic. Preoperative arterial and venous diameters, operative duration, immediate postoperative thrill, completion blood flow and intraoperative complications were recorded.

Outcome Assessment

The primary outcome was successful AVF maturation. Secondary outcomes included delayed maturation, primary maturation failure, time to maturation, time to first successful cannulation, requirement for assisted maturation, thrombosis, clinically significant stenosis, access-related infection, primary patency and secondary patency.

Primary patency was defined as continued AVF function without thrombosis or an intervention intended to maintain or restore patency. Secondary patency included continued access function following an intervention to restore or maintain patency.

Statistical Analysis

SPSS V26.0 was used for statistical analysis. Continuous variables were expressed as mean $\pm$ standard deviation or median with interquartile range according to distribution and compared using the independent-samples t-test or Mann-Whitney U test. Categorical variables were expressed as frequencies and percentages and compared using the chi-square or Fisher's exact test. Kaplan-Meier analysis was used to evaluate cumulative primary patency, with groups compared using the log-rank test. Multivariable logistic regression was performed to identify independent predictors of primary maturation failure, while Cox proportional-hazards regression was used to identify independent predictors of primary patency loss. A two-sided $p < 0.05$ was considered statistically significant.

RESULTS

A total of 700 patients undergoing native AVF creation for maintenance hemodialysis were analyzed. Of these, 322 patients (46.0%) had diabetes mellitus (Group A) and 378 patients (54.0%) did not (Group B). No missing values were encountered for any of the recorded variables. Continuous variables were tested for normality with the Shapiro-Wilk test and are reported as mean $\pm$ standard deviation when approximately normally distributed or as median with interquartile range (IQR) otherwise; comparisons used the independent-samples t-test or the Mann-Whitney U test as appropriate. Categorical variables are reported as frequencies and percentages and were compared with the chi-square test (or Fisher's exact test where expected cell counts were small).

Baseline Demographic and Clinical Characteristics

Patients with diabetes were, on average, older than non-diabetic patients (58.2 ± 8.3 vs. 51.7 ± 12.3 years, $p < 0.001$) and had a higher body mass index (median 27.6 vs. 23.8 kg/m², $p < 0.001$). The sex distribution was similar between groups (male sex 56.2% vs. 61.4% , $p = 0.191$). Diabetic patients had spent a longer time on dialysis before AVF creation (median 6.2 vs. 4.4 months, $p < 0.001$) and carried a substantially heavier comorbid burden, with a higher prevalence of hypertension, ischemic

heart disease, peripheral vascular disease, and dyslipidaemia (all $p < 0.001$); smoking history did not differ significantly between groups ($p = 0.588$). Diabetic patients had lower hemoglobin and serum albumin and higher serum phosphate and blood urea (all $p < 0.001$ to $p = 0.012$), while serum creatinine and calcium were comparable between groups. Among diabetic patients, mean HbA1c was $7.9 \pm 1.4\%$ and the mean duration of diabetes was 9.2 ± 4.6 years. Full baseline characteristics are presented in Table 1.

Table 1. Baseline demographic and clinical characteristics of study participants

Variable	Diabetic (n=322)	Non-Diabetic (n=378)	p-value
Age, years, mean $\pm$ SD	58.2 ± 8.3	51.7 ± 12.3	<0.001
Male sex, n (%)	181 (56.2)	232 (61.4)	0.191
BMI, kg/m ² , median (IQR)	27.6 (24.8–30.6)	23.8 (21.3–26.1)	<0.001
Duration on dialysis prior to AVF, months, median (IQR)	6.2 (3.7–9.7)	4.4 (2.6–7.0)	<0.001
Hypertension, n (%)	275 (85.4)	197 (52.1)	<0.001
Ischemic heart disease, n (%)	101 (31.4)	38 (10.1)	<0.001
Peripheral vascular disease, n (%)	78 (24.2)	35 (9.3)	<0.001
Ever smoker, n (%)	118 (36.6)	130 (34.4)	0.588
Dyslipidemia, n (%)	188 (58.4)	107 (28.3)	<0.001
Hemoglobin, g/dL, mean $\pm$ SD	10.2 ± 1.3	10.7 ± 1.3	<0.001
Serum albumin, g/dL, mean $\pm$ SD	3.5 ± 0.5	3.8 ± 0.4	<0.001
Serum creatinine, mg/dL, median (IQR)	7.2 (5.6–8.8)	7.4 (5.8–9.2)	0.120
Blood urea, mg/dL, mean $\pm$ SD	118.9 ± 32.0	113.0 ± 30.1	0.012
Serum calcium, mg/dL, mean $\pm$ SD	8.7 ± 0.8	8.7 ± 0.7	0.908
Serum phosphate, mg/dL, mean $\pm$ SD	5.4 ± 1.3	4.9 ± 1.1	<0.001
HbA1c, %, mean $\pm$ SD*	7.9 ± 1.4	—	—
Duration of diabetes, years, mean $\pm$ SD*	9.2 ± 4.6	—	—

*Reported among diabetic patients only (not applicable to the non-diabetic group). SD, standard deviation; IQR, interquartile range.

Operative and AVF Characteristics

Radiocephalic AVF was the most common configuration in both groups, although diabetic patients underwent proportionally fewer radiocephalic and more brachiocephalic and brachio basilic fistulae than non-diabetic patients (overall distribution $p = 0.037$). Preoperative

vascular mapping showed smaller arterial (2.03 ± 0.34 vs. 2.42 ± 0.39 mm, $p < 0.001$) and venous diameters (2.59 ± 0.46 vs. 3.03 ± 0.48 mm, $p < 0.001$) in diabetic patients, consistent with more advanced vascular disease. Operative duration was longer in the diabetic group (median 39 vs. 31 minutes, $p < 0.001$), an intraoperative

thrill was less frequently palpable immediately after fistula creation (80.1% vs. 95.0%, $p < 0.001$), and postoperative blood flow on completion Doppler was lower (533.8 ± 178.6 vs. 720.8 ± 190.5 mL/min, $p < 0.001$). Intraoperative

complications, most often arterial spasm or bleeding, were more frequent among diabetic patients (9.9% vs. 4.8%, $p = 0.012$). Details are shown in Table 2 and Figure 1 (preoperative vessel calibre).

Table 2. Operative and arteriovenous fistula characteristics

Variable	Diabetic (n=322)	Non-Diabetic (n=378)	p-value
Radiocephalic AVF, n (%)	150 (46.6)	208 (55.0)	
Brachiocephalic AVF, n (%)	140 (43.5)	147 (38.9)	0.037
Brachiobasilic AVF, n (%)	32 (9.9)	23 (6.1)	
Left-sided AVF, n (%)	312 (96.9)	366 (96.8)	1.000
Preoperative arterial diameter, mm, mean $\pm$ SD	2.03 ± 0.34	2.42 ± 0.39	<0.001
Preoperative venous diameter, mm, mean $\pm$ SD	2.59 ± 0.46	3.03 ± 0.48	<0.001
Operative duration, min, median (IQR)	39 (29–49)	31 (21–40)	<0.001
Postoperative blood flow, mL/min, mean $\pm$ SD	533.8 ± 178.6	720.8 ± 190.5	<0.001
Immediate thrill present, n (%)	258 (80.1)	359 (95.0)	<0.001
Intraoperative complication, n (%)	32 (9.9)	18 (4.8)	0.012

Preoperative Vessel Diameters by Diabetes Status

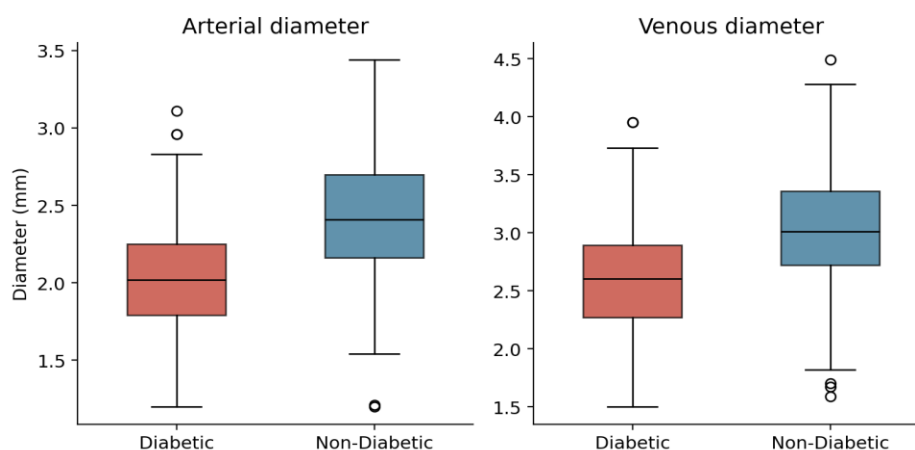


Figure 1. Preoperative arterial and venous diameters were significantly smaller in diabetic patients (Mann–Whitney U, $p < 0.001$ for both comparisons).

AVF Maturation Outcomes

Successful AVF maturation was achieved in 199 of 322 diabetic patients (61.8%) compared with 320 of 378 non-diabetic patients (84.7%), while primary failure occurred in 16.5% of diabetic

patients versus 5.3% of non-diabetic patients (overall $p < 0.001$ across maturation categories; Figure 2). Among fistulae that matured, diabetic patients took substantially longer to reach maturity (median 63 vs. 44 days, $p < 0.001$) and to

achieve first successful cannulation (median 72 vs. 53 days, $p<0.001$). Diabetic patients were also nearly three times more likely to require an assisted maturation procedure, such as balloon-assisted maturation or accessory vein ligation, to achieve a usable access (34.5% vs. 12.2%,

$p<0.001$). During follow-up, diabetic patients experienced significantly more thrombosis (24.2% vs. 6.9%, $p<0.001$), clinically significant stenosis (23.0% vs. 5.8%, $p<0.001$), and access-related infection (9.6% vs. 3.4%, $p=0.001$). These findings are summarized in Table 3.

Table 3. AVF maturation outcomes and follow-up complications

Outcome	Diabetic (n=322)	Non-Diabetic (n=378)	p-value
Successful maturation, n (%)	199 (61.8)	320 (84.7)	<0.001
Delayed maturation, n (%)	70 (21.7)	38 (10.1)	<0.001
Primary failure, n (%)	53 (16.5)	20 (5.3)	
Time to maturation, days, median (IQR)†	63 (53–80)	44 (38–51)	<0.001
Time to first successful cannulation, days, median (IQR)†	72 (62–89)	53 (45–62)	<0.001
Assisted maturation intervention required, n (%)	111 (34.5)	46 (12.2)	<0.001
Thrombosis during follow-up, n (%)	78 (24.2)	26 (6.9)	<0.001
Clinically significant stenosis, n (%)	74 (23.0)	22 (5.8)	<0.001
Access-related infection, n (%)	31 (9.6)	13 (3.4)	0.001

† Calculated among fistulae that achieved maturation (successful or delayed), n=269 diabetic and n=358 non-diabetic.

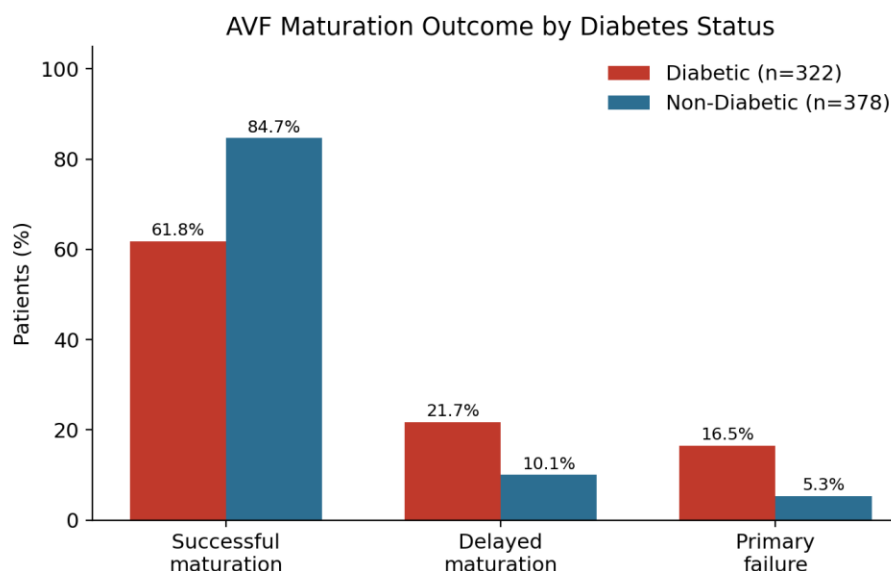


Figure 2. Distribution of AVF maturation outcomes by diabetes status ($\chi^2 = 68.4$, $p<0.001$).

Primary and Secondary Patency

Among fistulae that achieved maturation, primary patency was consistently lower in diabetic patients at every assessed time point: 84.8% vs. 93.0% at 3 months ($p=0.001$), 67.3% vs. 83.2% at 6 months ($p<0.001$), and 24.5% vs. 52.5% at 12 months

($p<0.001$). Secondary patency at 12 months, which incorporates fistulae salvaged by an intervention, was also lower among diabetic patients (58.0% vs. 86.6%, $p<0.001$), indicating that the patency disadvantage in diabetes was not fully offset by remedial procedures (Table 4).

Table 4. Primary and secondary patency rates by diabetes status

Outcome	Diabetic	Non-Diabetic	p-value
Primary patency at 3 months‡, n/N (%)	228/269 (84.8)	333/358 (93.0)	0.001
Primary patency at 6 months‡, n/N (%)	181/269 (67.3)	298/358 (83.2)	<0.001
Primary patency at 12 months‡, n/N (%)	66/269 (24.5)	188/358 (52.5)	<0.001
Secondary patency at 12 months‡, n/N (%)	156/269 (58.0)	310/358 (86.6)	<0.001

‡ Denominator restricted to fistulae that achieved maturation ($n=269$ diabetic, $n=358$ non-diabetic); p-values from chi-square test.

To account for differing follow-up experience and censoring, primary patency was additionally analyzed using the Kaplan–Meier method, with fistulae that never matured (primary failure) treated as an immediate loss of patency. Diabetic patients had significantly lower cumulative primary patency probability across the 12-month

follow-up period (estimated patency of 70.8%, 56.2%, and 20.5% at 3, 6, and 12 months, respectively) compared with non-diabetic patients (88.1%, 78.8%, and 49.7% at the same time points). The log-rank test confirmed a statistically significant difference in patency survival between groups ($\chi^2 = 74.7$, $p<0.001$; Figure 3).

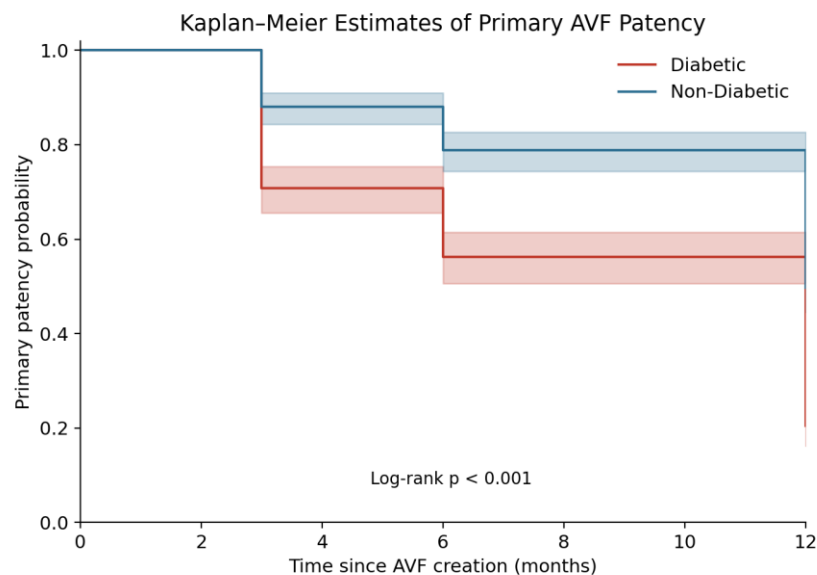


Figure 3. Kaplan–Meier estimates of cumulative primary AVF patency in diabetic versus non-diabetic patients. Shaded bands represent 95% confidence intervals; log-rank $p<0.001$.

Predictors of AVF Maturation Failure

On multivariable logistic regression adjusting for age, sex, hypertension, peripheral vascular disease, preoperative arterial and venous diameter, AVF location, and duration on dialysis, diabetes mellitus remained an independent predictor of primary AVF maturation failure (adjusted OR 4.56, 95% CI 2.21–9.44, $p<0.001$). None of the other covariates reached statistical significance in the adjusted model, although hypertension showed a trend toward a protective association

(adjusted OR 0.59, 95% CI 0.33–1.07, $p=0.082$) that did not reach significance, and older age showed a similar non-significant trend toward increased risk ($p=0.074$). A sensitivity analysis using a broader definition of maturation failure (primary failure or delayed maturation combined) yielded a materially similar, independently significant association with diabetes (adjusted OR 3.61, 95% CI 2.20–5.93, $p<0.001$). Results of the primary model are shown in Table 5.

Table 5. Multivariable logistic regression for predictors of AVF primary maturation failure

Predictor	Adjusted OR	95% CI	p-value
Diabetes mellitus	4.56	2.21–9.44	<0.001
Age (per year)	1.02	1.00–1.05	0.074
Male sex	1.34	0.80–2.26	0.268
Hypertension	0.59	0.33–1.07	0.082
Peripheral vascular disease	0.84	0.43–1.62	0.598
Preoperative arterial diameter (per mm)	1.13	0.56–2.27	0.730
Preoperative venous diameter (per mm)	1.22	0.71–2.09	0.470
Radiocephalic location (vs. proximal)	0.76	0.46–1.26	0.285
Duration on dialysis (per month)	0.98	0.93–1.04	0.536

Predictors of Loss of Primary Patency

A Cox proportional hazards model was constructed for time to loss of primary patency, adjusting for age, sex, hypertension, ischemic heart disease, peripheral vascular disease, smoking, AVF location, preoperative vessel diameters, and duration on dialysis (concordance index 0.646). Diabetes mellitus was independently associated with more than a two-fold increase in the hazard of patency loss (adjusted HR 2.62, 95% CI 2.02–3.42, $p<0.001$), confirming the unadjusted Kaplan–Meier and cross-sectional findings. A larger preoperative venous diameter was paradoxically associated with a higher hazard of

patency loss (adjusted HR 1.29, 95% CI 1.05–1.58, $p=0.014$), and a history of smoking was associated with a modestly lower hazard (adjusted HR 0.79, 95% CI 0.65–0.97, $p=0.024$); both findings should be interpreted cautiously, as they run counter to typical clinical expectation and may reflect residual confounding rather than a genuine protective or harmful effect. No other covariate, including age, sex, hypertension, ischemic heart disease, peripheral vascular disease, AVF location, arterial diameter, or dialysis duration, was independently associated with patency loss (Table 6)

Table 6. Multivariable Cox proportional hazards regression for predictors of loss of primary AVF patency

Predictor	Adjusted HR	95% CI	p-value
Diabetes mellitus	2.62	2.02–3.42	<0.001
Age (per year)	1.00	0.99–1.01	0.643
Male sex	1.01	0.83–1.22	0.955

Hypertension	1.03	0.82–1.28	0.805
Ischemic heart disease	0.91	0.72–1.15	0.431
Peripheral vascular disease	0.94	0.73–1.21	0.636
Ever smoker	0.79	0.65–0.97	0.024
Radiocephalic location (vs. proximal)	0.91	0.75–1.10	0.313
Preoperative arterial diameter (per mm)	0.89	0.69–1.16	0.398
Preoperative venous diameter (per mm)	1.29	1.05–1.58	0.014
Duration on dialysis (per month)	0.99	0.97–1.01	0.370

Summary of Key Findings

In summary, patients with diabetes mellitus achieved successful AVF maturation less often (61.8% vs. 84.7%), took longer to mature and to be successfully cannulated, required assisted maturation procedures more frequently, and experienced markedly lower primary and secondary patency throughout 12 months of follow-up compared with non-diabetic patients. These associations persisted after multivariable adjustment for other relevant clinical and vascular factors, with diabetes mellitus emerging as an independent predictor of both maturation failure (adjusted OR 4.56) and loss of primary patency (adjusted HR 2.62).

DISCUSSION

This study demonstrates a strong and clinically important association between diabetes mellitus and adverse AVF outcomes. Among 700 consecutive patients, diabetic patients had substantially lower successful maturation than non-diabetic patients (61.8% vs. 84.7%), more primary failure (16.5% vs. 5.3%), longer median maturation time (63 vs. 44 days), longer time to first cannulation (72 vs. 53 days), and greater need for assisted maturation (34.5% vs. 12.2%). Diabetes remained independently associated with primary maturation failure after adjustment for relevant clinical and vascular variables (adjusted OR 4.56, 95% CI 2.21–9.44).

These findings are consistent with contemporary international evidence. Zhao et al. studied 477 hemodialysis patients and reported maturation rates of 47.98% in patients with type 2 diabetes

compared with 63.82% in non-diabetic patients; diabetes independently increased the risk of AVF non-maturation (OR 1.716) [10]. Similarly, Gan et al. identified diabetes as an independent factor influencing AVF maturation and subsequent AVF survival, while preoperative arterial and venous diameters were also important determinants [11]. The magnitude of association observed in our cohort is stronger, potentially reflecting the high burden of vascular comorbidity among our diabetic patients.

An important finding was the significantly smaller preoperative arterial and venous diameters in diabetic patients, accompanied by lower postoperative blood flow and less frequent immediate thrill. These observations provide a plausible physiological explanation for the poorer maturation observed. Contemporary studies emphasize that vascular calibre and postoperative hemodynamics influence AVF remodelling, while recent mechanistic evidence highlights endothelial dysfunction, inflammation, oxidative stress and vascular-wall abnormalities as contributors to maturation failure [3,8,10,18]. The HFM study further demonstrated that AVF maturation is a prolonged and intervention-intensive process, with substantial proportions requiring procedures to facilitate maturation [6].

The adverse effect of diabetes extended beyond maturation. In our study, diabetic patients had significantly greater thrombosis, stenosis and access-related infection. Primary patency among matured fistulas was 84.8%, 67.3% and 24.5% at 3, 6 and 12 months, respectively, compared with 93.0%, 83.2% and 52.5% in non-diabetic

patients. Twelve-month secondary patency was also markedly lower in diabetic patients (58.0% vs. 86.6%). Kaplan-Meier analysis confirmed persistently inferior cumulative primary patency, while diabetes independently increased the hazard of patency loss more than two-fold (adjusted HR 2.62).

These findings are particularly comparable with Pakistani evidence. Rehman et al., from Aga Khan University Hospital, reported similar maturation rates between diabetic and non-diabetic patients undergoing brachio basilic AVF but significantly lower six-month patency among diabetics (64.7% vs. 87.0%) [16]. Thus, their findings support our observation that diabetes may exert a stronger influence on durability than on maturation in selected proximal fistulas. In contrast, our study demonstrates a substantial adverse effect on both maturation and patency across different AVF configurations. Azeem et al., in a 726-patient Pakistani cohort, also reported clinically important differences in AVF patency and complications according to timing of AVF creation, highlighting the importance of timely vascular-access planning [15]. Other Pakistani data have documented thrombosis, infection and bleeding as clinically relevant AVF complications [17,18].

International evidence similarly demonstrates considerable variation in AVF outcomes. The DOPPS analysis found important international differences in AVF patency and time to becoming catheter-free, emphasizing the influence of access-planning pathways and healthcare systems [7]. Huber et al. reported that approximately one-third of AVFs required interventions before maturation, while almost half of matured accesses subsequently required intervention to maintain function [6]. Our higher intervention requirement among diabetic patients therefore appears biologically and clinically plausible rather than unexpected.

The practical implications are important. Diabetic patients should undergo careful preoperative vascular assessment, preservation of suitable vessels, individualized selection of access location and early postoperative surveillance. Recent

evidence indicates that early postoperative assessment can shorten time to cannulation and catheter-free dialysis [19]. In a resource-constrained setting such as Pakistan, preventing maturation failure may be particularly valuable because prolonged catheter dependence increases exposure to infectious and central venous complications. Nevertheless, the single-center observational design limits generalizability, and residual confounding from diabetes duration, glycemic control, vascular calcification and surgical factors cannot be excluded.

CONCLUSION

Diabetes mellitus was strongly associated with impaired AVF maturation and reduced primary patency in this 700-patient cohort from a cardiovascular surgery center in Sialkot. Diabetic patients had lower maturation, greater primary failure, delayed cannulation, more assisted maturation procedures and substantially higher thrombosis and stenosis rates. Diabetes remained an independent predictor of both maturation failure and loss of primary patency. These findings support early vascular assessment, individualized AVF planning and closer postoperative surveillance of diabetic patients to improve access usability and durability.

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