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Original Article

Risk Factors for Primary Failure of Arteriovenous Fistula in Chronic Kidney Disease Patients on Hemodialysis

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Abstract

Objective: To determine the factors that contribute to primary arteriovenous fistula failure in chronic kidney disease patients receiving hemodialysis.

Methodology: This case control study was carried out in the Department of Nephrology, Bahawal Victoria Hospital, Bahawalpur over six month period. 80 eligible patients with chronic kidney disease receiving hemodialysis were recruited after meeting the study inclusion criteria; 40 cases (with primary AVF failure) and 40 controls (without primary AVF failure). Basic demographic details such as age, gender, duration of CKD and duration since patient was on hemodialysis through AVF were noted. The risk factors in the form of diabetes mellitus, obesity, smoking, peripheral vascular disease (PVD) and type of AVF were noted.

Results: Mean age of the study participants was 53.5 ± 12.1 years. There were 60% males. Female distribution was significantly higher (68.8%) in cases compared to controls (31.2%). Diabetes and PVD were significantly more common in cases (68.4%, 68.6%) compared to controls (31.6%, 31.4%). The cases had 3.7 (95% CI: 1.4-9.5) odds of being females, 4.3 (95% CI: 1.7-11.1, p-value 0.002) odds of being diabetics, 3.9 (95% CI: 1.55-10.1, p-value 0.003) odds of having PVD compared to controls.

Conclusion: Our findings indicate that diabetes and female sex are the only independent risk factors for primary AVF failure.

Keywords: "Arteriovenous Fistula, Factors, Chronic Kidney Disease, Failure, Hemodialysis."

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Introduction

Chronic kidney disease (CKD) is characterized by permanent renal parenchymal degradation and a steady loss in kidney function.[1] Between 4.902 and 7.083 million people with CKD are thought to require renal replacement therapy.[2] Despite significant medical and technical advancements in renal transplantation and peritoneal dialysis (PD), hemodialysis (HD) is still the backbone of care for these patients.[3]

An arteriovenous fistula is a permanent form of vascular access used for hemodialysis, established from the natural blood channels.[4] The forearm (radiocephalic) fistula is the most common site for arteriovenous fistula creation, although upper arm (brachiocephalic) fistulas may also be constructed.[5] Arteriovenous fistulas (AVFs) have been shown to enhance hemodialysis patient's survival when compared to central venous catheters (CVCs) for vascular access.[6]

From all produced fistulae, 60% to 80% mature to an adequate AVF. The main reason for AVF primary failure is thrombosis. Moreover, it is the main reason for lost access indefinitely.[7] Primary failure of AVF has been associated with several clinical factors, including age above 65 years, female sex, uremia, diabetes mellitus, PVD, and non-white ethnicity.[8]

In their study, Budak AB et al looked at 168 individuals with ESRD who were split into two groups: those who experienced early failure (n=46) and those who did not have any failure (n=122). It was shown that being a woman was a major risk factor for early failure of AVF (69.5% versus 36.1%; p=0.001). In the early failure group, there were substantially more patients with cephalic vein diameters less than 2 mm (78.3% versus 22.1%; p=0.028).[9] The medical

records of 178 patients with end-stage renal disease (ESRD) who had undergone arteriovenous fistula creation were reviewed by Gjorgjievski N et al, revealing 16.29% (29/178) of the produced fistulae experienced primary AVF failure, while 10.11% (18/178) experienced early thrombosis.[10] Amadis MR and colleagues conducted a retrospective cohort study involving 225 arteriovenous fistulas created in 159 patients. AVF formation at the wrist showed a significantly higher early failure rate than AVF creation at the elbow (29.9% vs. 4.4%; $p < 0.001$).[11]

This study's objective is to assess the risk factors for primary AVF failure in hemodialysis patients in our community. In order to properly inform decision-making on vascular access, it is crucial to examine local rates of AVF primary failure and variables related with them. The results of our investigation would make it easier to develop regionally appropriate prediction algorithms for classifying patients into pertinent groups at risk for primary AVF maturation failure.

Methodology

This case control study was carried out in the department of Nephrology, Bahawal Victoria Hospital, Bahawalpur from 16th August 2025 to 15th January 2026. The sample size was estimated using the WHO calculator, keeping 5% level of significance, 80 % power of test, 69.5 % anticipated frequency of females in primary AVF failure group and 36.1 % anticipated frequency of females in non AVF failure group. 80 patients, aged between 18-70 years, of both genders, having chronic kidney disease and on hemodialysis through AVF for more than 3 months were selected and included in the study after informed consent. There were 40 cases (CKD patients on hemodialysis through AVF, and having primary failure of AVF), and 40 control (CKD patients on hemodialysis through AVF, not having primary AVF failure). Patients who underwent corrective AVF surgery and those not willing to participate in study were excluded. The demographic data including age, gender, duration of CKD and time since patient was on hemodialysis through AVF was noted. The risk factors in the form of diabetes mellitus, obesity, smoking, PVD and type of AVF were noted. All the data was recorded on a proforma.

The data was analyzed through SPSS v. 25. The quantitative variables like age, duration of CKD and duration of hemodialysis through AVF were presented as mean and standard deviation. The qualitative variables like gender, diabetes mellitus, obesity, smoking, peripheral vascular disease and type of AVF were presented as frequency and percentages. Risk factors of primary AVF failure were assessed through logistic regression analysis. At first step, bivariate analysis was done and crude odds ratio with 95% confidence interval was reported. P-value for bivariate analysis was 0.20. Variables significant at bivariate analysis were entered in multivariable analysis for independent risk factors. Adjusted odds ratios with corresponding 95% confidence intervals were calculated, and p-value for multivariable analysis was 0.05.

Results

Forty patients with primary AVF failure (cases) and forty without primary AVF (controls) were enrolled in the study. Mean age of the study participants was 53.5 ± 12.1 years. There were 60% (n=48) males in the study group. Mean duration of CKD was 3.9 ± 1.7 years and mean duration of hemodialysis through AVF was 11.2 ± 7.9 months. Radiocephalic type of AVF was most common (n=44, 55%) followed by

Table 1: *Demographic characteristics of CKD patients undergoing hemodialysis through AVF (N=80)*

Characteristics	All (N=80)	Cases (n=40)	Controls (n=40)	p-value*
Age (years), mean ± SD	53.5 ± 12.1	53.8 ± 11.9	53.2 ± 12.6	0.82
Gender, n(%)				
Male	48 (60)	18 (37.5)	30 (62.5)	0.006
Female	32 (40)	22 (68.8)	10 (31.2)	
Duration (years) of CKD (mean ± SD)	3.9 ± 1.7	3.8 ± 1.6	4.2 ± 1.8	0.247
Type of AVF, n(%)				
Radiocephalic	44 (55)	20 (45.5)	24 (54.5)	0.579
Brachiocephalic	30 (37.5)	16 (53.3)	14 (46.7)	
Radiobasilic	06 (7.5)	04 (66.7)	2 (33.3)	
Duration (months) of hemodialysis (mean ± SD)	11.2 ± 7.9	11.4 ± 7.4	10.9 ± 8.5	0.759

*"*Independent sample t-test for numerical data, chi-square test for qualitative data"*

brachiocephalic type in 37.5% (n=30). Age, duration of CKD, type of AVF and duration of hemodialysis did not differ significantly between case and controls. Female distribution was significantly higher (68.8%) in cases compared to controls (31.2%) [Table 1].

There were 17.5% (n=14) obese participants, 47.5% (n=38) were diabetics, 32.5% (n=26) were smokers and 43.7% (n=35) had peripheral vascular disease. Diabetes was significantly more common in cases (68.4%) compared to controls (31.6%). Similarly, peripheral vascular disease was significantly more prevalent in cases (68.6%) compared to control (31.4%) [Table 2].

The cases had 3.7 (95% CI: 1.4-9.5) odds of being females compared to controls. Cases had 4.3 (95% CI: 1.7-11.1, p-value 0.002) odds of being diabetics compared to controls. Cases had 3.9 (95% CI: 1.55-10.1, p-value 0.003) odds of having peripheral vascular disease compared to controls [Table 3].

After controlling for other demographic and comorbid conditions, presence of diabetes mellitus and female gender were the only independent risk factors of primary AVF failure in multivariable logistic regression analysis.

Discussion

In order to successfully create and mature AVF in patients with CKD, many disciplines must work together to address the fundamental reasons of failure. Although numerous studies have examined the pathophysiology and biomechanical factors involved in AVF maturation, the process remains complex and is not yet fully understood. The principal pathohistological alteration in the blood vessels that is linked to the initial failure of AVF has been identified as intimal hyperplasia.[12] For patients who require a functional permanent vascular access for hemodialysis, the construction of an AVF is the initial step. In our study, the cases had 3.7 odds of being females, 4.3 odds of being diabetics and 3.9 odds of having peripheral vascular disease compared to controls. AVF patients who were recruited in a thorough follow-up program had an appropriate AVF maturation rate of 82% and a primary failure rate of 18%, according to Mc Lafferty et al, in 2007.[13] Numerous researches have concentrated on the elements that indicate a functioning, effective AVF. From a total of 97 fistulae, Bashar et al, in 2015, reported 52 functionally developed fistula (53.60%). In their study, lower hemoglobin levels and female gender (p = 0.004), the use of calcium channel blockers at the time of AVF creation (p = 0.01), and a history of kidney transplantation (p = 0.036) were all significantly associated with AVF function.[14] This does not relate to our observations where female gender was more associated with AVF failure. In comparison to men, Jemcov, in 2013, found that female gender was related with longer AVF development (OR 0.35, 95% CI = 0.17-0.72; p = 0.005).[15] According to a 2010 study by Wasse et al, women were 36% less likely than men to utilize an AVF while starting hemodialysis.[16] According to the Miller et al, in 2003, women were more likely than males to have a fistula in their upper arm as opposed to their forearm (64% vs. 36%).[17] In our study, Radiocephalic type of AVF was most common (55%) followed by brachiocephalic type in 37.5% cases.

In the study by Gjorgjievski et al., male patients were significantly more likely than female patients to undergo distal fistula formation (51 vs. 18; p = 0.015). The main failure of AVF was not substantially correlated with the quantity or location of AVF.[10] Our study results also showed that age, duration of CKD, type of AVF and duration of hemodialysis did not differ significantly between case and controls. DM has been identified as the most prevalent cause of CKD, however unlike the other major renal illnesses, it was not linked to an undesirable result of fistula

Table 2: *Distribution of co-morbid conditions in CKD patients undergoing hemodialysis through AVF (N=80)*

Co-morbidities		All (N=80)	Cases (n=40)	Controls (n=40)	p-value*
Obesity	Yes	14 (17.5)	04 (28.6)	10 (71.4)	0.139
	No	66 (82.5)	36 (54.5)	30 (45.5)	
Diabetes mellitus	Yes	38 (47.5)	26 (68.4)	12 (31.6)	0.002
	No	42 (52.5)	14 (33.3)	28 (66.7)	
Smoking	Yes	26 (32.5)	11 (42.3)	15 (57.7)	0.34
	No	54 (67.5)	29 (53.7)	25 (46.3)	
Peripheral Vascular Disease	Yes	35 (43.7)	24 (68.6)	11 (31.4)	0.003
	No	45 (56.3)	16 (35.6)	29 (64.4)	

*"*Chi-square test, Fischer's exact test where cell count < 5"*

maturation during the first three years of its formation.[18] According to Sedlacek et al's data from 2001, DM was not linked to adverse AVF maturation (67% of the diabetic group's AVFs matured compared to 62% of the non-diabetic group's). The prevalence of AVF genesis in patients was unaffected by DM as a condition.[19] Kinnaert P et al discovered that women had a reduced chance of an AV fistula survival than males, which is consistent with our findings.[20] A study by Ernandez T et al. identified distal AVF location, female gender, surgical expertise level and diabetes mellitus as significant predictors of early AVF failure.[21] These findings are also relatable with our results.

Age above 60 and the presence of peripheral vascular disease both substantially impacted fistula patency, according to a study by Field M et al (P=0.001 and P=0.048, respectively).[22] An elevated risk of AVF failure has been connected to peripheral vascular

Table 3: *Bivariate Logistic Regression Analysis For Risk Factors Of Primary Avf Failure In Ckd Patients Undergoing Hemodialysis Through AVF (n=80)*

Factors	Cases (n=40)	Control (n=40)	Crude Odds Ratio (95% CI)	p-value*
Age Groups				
Up to 50-year	17 (43.6)	22 (56.4)	0.61 (0.25-1.46)	0.263
> 50-year	23 (56.1)	18 (43.9)		
Gender				
Female	22 (68.8)	10 (31.2)	3.7 (1.4-9.5)	0.007
Male	18 (37.5)	30 (62.5)	1 (Ref)	
Duration of CKD				
Up to 3-years	22 (59.5)	15 (40.5)	2.04 (0.83-4.98)	0.116
> 3-years	18 (41.9)	25 (58.1)	1 (Ref)	
Duration of Dialysis through AVF				
Up to 10-months	19 (44.2)	24 (55.8)	0.60 (0.25-1.46)	0.262
> 10-months	21 (56.8)	16 (43.2)	1 (Ref)	
Type of AVF				
Radiocephalic	20 (45.5)	24 (54.5)	1 (Reference)	
Brachiocephalic	16 (53.3)	14 (46.7)	1.37 (0.54-3.48)	0.506
Radiobasilic	4 (66.7)	2 (33.3)	2.4 (0.40-14.50)	0.34
Diabetes Mellitus				
Yes	26 (68.4)	12 (31.6)	4.3 (1.7-11.1)	0.002
No	14 (33.3)	28 (66.7)	1 (Ref)	
Smoking				
Yes	11 (42.3)	15 (57.7)	0.63 (0.25-1.63)	0.34
No	29 (53.7)	25 (46.3)	1 (Ref)	
Peripheral Vascular Disease				
Yes	24 (68.6)	11 (31.4)	3.9 (1.55-10.1)	0.003
No	16 (35.6)	29 (64.4)	1 (Ref)	
Obesity				
Yes	04 (28.6)	10 (71.4)	0.33 (0.09-1.17)	0.139
No	36 (54.5)	30 (45.5)	1 (Ref)	

*"*Chi-square test, Fischer's exact test where cell count < 5"*

disease. Small arteries like the radial artery at the wrist can have their intima media thickness (IMT) measured using modern high-frequency US scanners with high-resolution imaging capabilities.[23] According to experts in the creation and management of permanent vascular access for hemodialysis, doppler ultrasonography plays a critical role in both preoperative vessel mapping to select suitable vessels for AVF creation and in the early detection of complications during postoperative surveillance. Silva et al's study from 1998, one of the early investigations, described the use of preoperative duplex imaging on forearm veins to pinpoint potential locations for AVF creation.[24] When the internal diameter of the artery was less than 1.5 mm, Malovrh, in 1998, found that the likelihood of AVF failure rose, with a success rate of only 45%. His research showed that duplex sonography, a non-invasive technique, allowed for an adequate examination of the arteries prior to the development of an AVF.[25]

Conclusion

This study concludes that diabetes mellitus and female gender are the only independent risk factors for primary arteriovenous fistula failure. Factors contributing to AVF failure may differ across populations. Therefore, identifying local determinants of AVF failure and predictors of AVF patency is essential to support appropriate vascular access planning.

Ethical Approval: The IRB/EC approved this study via letter no. 569/DME/QAMC Bahawalpur dated January 21, 2026.

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Authors' Contribution

NA: Conception.

AK: Design of the work.

UH,MA: Data acquisition, analysis, or interpretation.

NA, UH, MA: Draft the work.

AK: Review critically for important intellectual content.

All authors approve the version to be published.

All authors agree to be accountable for all aspects of the work.

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