

## Comparison of Primary Failure Rates for Radiocephalic, Brachiocephalic and Brachio basilic Fistulas Between Patients of Diabetes and Non-Diabetes with Chronic Kidney Disease

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### ABSTRACT

**Objective:** To compare primary failure rates for radiocephalic, brachiocephalic and brachio basilic fistulas between patients with and without diabetes mellitus.

**Study Design:** Cross-sectional study.

**Place and Duration of Study:** Department of Vascular Surgery, Combined Military Hospital, Peshawar Pakistan Aug 2020 to Mar 2022.

**Methodology:** Patients with chronic kidney disease referred for arteriovenous fistula surgery were included. Groups of patients with and without diabetes were age and gender-matched. Pre-operative ultrasound mapping was used for sitting, with a 3 mm diameter outflow vein set as the minimum criterion. End-to-side anastomosis using a parachute technique was performed. Patients were followed up at two, four and six weeks after surgery to assess the functional status of fistulas clinically.

**Results:** There were 172 patients, including 71 with diabetes mellitus. The mean age was 54.67±20.56 years. Overall, there was no difference between the two groups in rates of primary fistula failure at six weeks 9(12.67%) vs 8(7.92%),  $p=0.304$ . Brachiocephalic fistulas were made in a greater proportion of patients with diabetes as compared to those without diabetes. At six weeks, 5(10.64%) of these amongst the former were non-functional, as compared to none in the latter group ( $p=0.024$ ). There was no difference in radiocephalic and brachio basilic fistula maturity rates between the two groups at the end of the sixth postoperative week.

**Conclusion:** Diabetes mellitus is associated with higher primary failure rates in brachiocephalic fistulas, but the outcomes are the same for radiocephalic and brachio basilic fistulas as compared to patients without diabetes.

**Keywords:** Diabetes, End-stage renal disease, Haemodialysis, Haemodialysis access, Surgery.

**How to Cite This Article:** Ullah S, Imtiaz N, Ullah S, Arshad AR. Comparison of Primary Failure Rates for Radiocephalic, Brachiocephalic and Brachio basilic Fistulas Between Patients of Diabetes and Non-Diabetes with Chronic Kidney Disease. *Pak Armed Forces Med J* 2024; 74(2): 415-419. DOI: <https://doi.org/10.51253/pafmj.v74i2.8514>

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### INTRODUCTION

With progressive increases in life expectancy and the availability of better healthcare services, the incidence of end-stage renal disease (ESRD) is on the rise. It has been estimated that almost 13.4% of the world population has chronic kidney disease (CKD), and nearly five to seven million people require renal replacement therapy.<sup>1</sup> In our country, most patients are on maintenance hemodialysis. The utilisation of kidney transplants is not that common, mainly because of the shortage of donors and cost. Peritoneal dialysis is almost non-existent.<sup>2,3</sup>

Diabetes mellitus is well known to be the most common cause of CKD/ ESRD.<sup>4</sup> It is associated with accelerated atherosclerosis. Whereas these changes in vascular homeostasis are generally perceived to be

dangerous because of an increased risk of cerebral and cardiovascular diseases, nephrologists are also concerned about the effects on the structure of peripheral blood vessels. This is because well-functioning venous access is an absolute requirement for hemodialysis.<sup>5</sup> Arteriovenous fistulas (AVF) are still the Achilles heel of modern-day hemodialysis. Beyond any doubt, a long-lasting AVF improves the quality of life and reduces morbidity among patients with ESRD.<sup>6</sup> Ideally, an AVF should mature early and have minimal chances of primary failure. Successful creation of such an AVF relies fundamentally on the quality of the artery and vein being used for anastomosis. Diabetes mellitus and its associated atherosclerosis effectively narrows the lumen of these blood vessels and reduces the blood flow, thereby limiting utilisation as an effective conduit.<sup>7</sup>

The effect of diabetes mellitus on AVF maturity rates is debatable. There is evidence to support both sides of the argument.<sup>8</sup> However, local data from

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Received: 13 Apr 2022, revision received: 26 May 2022; accepted: 27 May 2022

Pakistan still needs to be made available. Racial differences in vascular stiffness and function are already known very well.<sup>2</sup> We hypothesised that Pakistani patients might behave differently than those from other world regions. Considering this, we planned this study to compare primary failure rates for radiocephalic, brachiocephalic and brachiobasilic AVF between patients with and without diabetes mellitus worldwide. The results might elaborate on the need for a different holistic approach towards AVF creation amongst patients with diabetes mellitus.

## METHODOLOGY

The cross-sectional study was conducted at the Department of Vascular Surgery, Combined Military Hospital Peshawar, Pakistan from August to March 2022, after approval from the Ethics Review Committee was obtained (Reference number: 00205). The sample size was calculated using the Epitools sample size calculator, assuming primary AVF failure rates of 62.5% in patients with diabetes mellitus and 38.8% in patients without diabetes mellitus.<sup>9</sup> All patients were consecutively included in this study.

**Inclusion criteria:** Patients of either gender with chronic kidney disease referred for AVF surgery were included.

**Exclusion criteria:** Patients with a previously failed AVF or those getting a graft were excluded.

Informed written consent was taken from all the participants. Demographic data of all the participants was recorded. The site for AVF was selected based on pre-operative ultrasound mapping. Preference was given to the non-dominant arm, and a 3 mm diameter for the outflow vein was set as the minimum criterion. All patients underwent hemodialysis on the day before surgery. During the surgery, unfractionated heparin of 5000 units was given intravenously just before clamping the artery. End-to-side anastomosis using a parachute technique was performed. Round body non-absorbable prolene suture was used for anastomosis. Brachiobasilic AVF was made in two stages. Initially, anastomosis between the artery and vein was made, whereas lateralisation of the vein was done four weeks later. Patients were followed up in an outdoor clinic at two, four and six weeks after surgery. The functional status of AVF was recorded during the clinical examination. The absence of thrill and bruit was confirmed by Doppler scan in selected cases only.

Data was analysed using Social Package for Statistical Sciences (SPSS) version 24. All quantitative

variables were described as Mean±standard deviation and qualitative variables were expressed as frequency and percentages. Patency rates for different types of AVF were compared among patients with and without diabetes mellitus using the chi-square test. The *p*-value of 0.05 or less was taken as significant.

## RESULTS

A total of 172 patients, including 71(41.28%) with diabetes mellitus and 101(58.72%) without diabetes mellitus, were included in this study. Their mean age was 54.67±20.56 years. Patients in the two groups had similar ages, gender distribution and body mass index. Those having diabetes mellitus had a greater frequency of co-existent hypertension and a higher estimated glomerular filtration rate at the time of surgery as compared to patients without diabetes mellitus, (Table-I). A comparison of different sites for AVF surgery between patients with and without diabetes mellitus is shown in Table-II. Whereas patients without diabetes mellitus had almost equal proportions of brachiocephalic and brachiocephalic AVF made, the latter type was more commonly made in patients with diabetes mellitus 47(66.20%) vs 20(28.17%). Brachiobasilic AVF were made in only four patients with diabetes mellitus and twelve without diabetes mellitus.

**Table-I: Baseline Characteristics of Study Participants (n=172)**

Baseline Characteristics	Study Groups		<i>p</i> -value
	Patients with Diabetes Mellitus (n=71)	Patients without Diabetes Mellitus (n=101)	
Age (years)	54.89±20.32	54.51±20.83	0.906
<b>Gender</b>			
Male	51(71.83%)	81(80.19%)	0.201
Female	20(28.17%)	20(19.89%)	
<b>Co-existent hypertension</b>			
Yes	59(83.10%)	68(67.33%)	0.021
No	12 (16.90%)	33(32.67%)	
<b>Body Mass Index</b>			
(kg/m <sup>2</sup> )	25.45± 4.03	26.58±4.23	0.083
<b>eGFR</b>			
(ml/min/1.73m <sup>2</sup> )	13.28±3.41	11.89±2.63	0.003

In the overall cohort, a significantly greater number of AVF in patients with diabetes mellitus (7;9.86%) had failed by two weeks after surgery, as compared to none in patients without diabetes mellitus. A greater number of AVF in patients without diabetes mellitus failed in the subsequent weeks so that the difference in patency rates at the end of the

fourth 63(88.73%) vs 97(96.04%);  $p=0.064$ ) and sixth post-operative weeks 62(87.32%) vs 93(92.08%);  $p=0.304$ ) was not statistically significant. These findings are depicted in Table-III.

**Table-II: Distribution of Arteriovenous Fistula Types (n=172)**

	Site of arteriovenous fistula			p-value
	Radiocephalic	Brachiocephalic	Brachiobasilar	
Patients with Diabetes Mellitus	20(28.17%)	47(66.20%)	4(5.63%)	0.018
Patients without Diabetes Mellitus	44(43.56%)	45(44.55%)	12(11.88%)	

**Table-III: Comparison of Patency Rates Between Patients with and Without Diabetes Mellitus (n=172)**

Time period	Study Groups		p-value
	Patients with Diabetes Mellitus (n=71)	Patients without Diabetes Mellitus (n=101)	
2 weeks	64(90.14%)	101(100.00%)	0.001
4 weeks	63(88.73%)	97(96.04%)	0.064
6 weeks	62(87.32%)	93(92.08%)	0.304

Three (15.00%) of the radiocephalic AVF in patients with diabetes mellitus failed at two weeks as compared to none in patients without diabetes mellitus ( $p=0.009$ ). However, failure rates were equal in both groups at the end of fourth as well as sixth week 4(20.00%) vs 4(9.09%);  $p=0.221$ ). In the case of brachiocephalic AVF, the outcomes were better in patients without diabetes mellitus throughout the study period. At both two and four weeks, 4(9.50%) of the 47 brachiocephalic AVF in patients with diabetes mellitus had failed, as compared to none in patients without diabetes mellitus ( $p=0.045$ ). At six weeks, 5(10.64%) AVF had failed in patients with diabetes mellitus compared to none without diabetes mellitus ( $p=0.024$ ). All the brachiobasilar AVF remained patent during the first four weeks. Four (25.00%) of the 12 AVF amongst patients without diabetes mellitus failed in the subsequent fortnight, as compared to none amongst patients with diabetes mellitus, but this difference was statistically insignificant ( $p=0.182$ ).

**DISCUSSION**

Our patients with diabetes mellitus had better renal excretory function at the time of AVF surgery. However, this study failed to show any difference in AVF maturity rates between patients with and without diabetes mellitus at the sixth post-operative week.

Though brachiocephalic AVFs were the most common ones made amongst patients with diabetes mellitus, the outcomes were poor for this intervention in this group.

In a cross-sectional study done on 195,756 patients in the United States, Lilly *et al.* showed that patients with diabetes mellitus had fewer chances of AVF maturation than patients without diabetes mellitus.<sup>10</sup> Amongst 182 AVFs made at Jinnah Postgraduate Medical Centre, Nawaz *et al.* found worse outcomes for patients with diabetes mellitus.<sup>11</sup> On the contrary, co-existent diabetes mellitus did not affect AVF maturation rates amongst 694 patients from Singapore.<sup>12</sup> Same was the case with 400 patients from the United Kingdom, as reported by Siddiqui *et al.*<sup>13</sup> In a recently published retrospective study, Gupta *et al.* also found that the outcome of AVF surgery was equally good amongst patients with and without diabetes mellitus. However, the proportion of patients with diabetes mellitus was quite low (16.67%) in this study.<sup>14</sup> Among Pakistani patients, Khan *et al.* also showed that co-existent diabetes mellitus did not affect AVF primary failure rates (11.35% in patients with diabetes mellitus vs 7.2% in patients without diabetes mellitus;  $p=0.45$ ).<sup>15</sup>

Brachiocephalic AVF were our patients' most common type of AVF, similar to results presented by Arif *et al.* from Lahore.<sup>16</sup> Studies from Asia have previously reported less frequent utilisation of radiocephalic AVF amongst patients with diabetes mellitus.<sup>17</sup> Our statistics are even lower than this. Brachiocephalic AVF generally has better patency rates than brachiocephalic AVF in patients with diabetes mellitus. Based on the results of 265 AVF created in patients with diabetes mellitus, Janeckova *et al.* concluded that initial AVF surgery at the elbow could be a better option than that at the wrist since this approach could mitigate the need for repeated surgeries.<sup>18</sup> The results from our study are unexpectedly different. One possible reason could be the effective pre-operative venous mapping, the results of which guided us towards relying more on brachiocephalic AVF in patients with diabetes mellitus. Nevertheless, this study highlights the importance of using AVF at the wrist amongst patients with adequately sized blood vessels.

There is a definite relationship between AVF maturity and arterial diameter.<sup>19</sup> Appropriate pre-operative blood vessel selection is paramount in predicting the successful maturation of AVF. The

surgeons did Venous mapping beforehand, so the most appropriate blood vessels were selected. Since the minimum requirement for vessel diameter was fulfilled in all cases, this could not be a reason for the poor maturity of some of the AVFs in this cohort. Female gender is also associated with a higher risk of AVF immaturity, probably because of smaller vessel diameter.<sup>20</sup> However, there were no differences in gender distribution amongst the two groups. Similarly, both groups were age-matched, thereby eliminating another bias. Among 74 patients undergoing single-stage brachiobasilic AVF, patency rates at the eighth week were equal amongst patients with and without diabetes (93.2% vs 95.5%) but were much lower in the former group at the end of six months (64.7% vs (87.0%).

The results of this study are interesting since they reinforce the importance of radiocephalic AVF in terms of better outcomes among patients with diabetes mellitus. All efforts should be made to go for this type of AVF rather than trying out brachiobasilic AVF straight away.

#### LIMITATION OF STUDY

Because fewer patients receive brachiobasilic AVF, this study was underpowered to detect meaningful differences in outcomes for this specific type of AVF. Studies involving more patients with brachiobasilic AVF are suggested to investigate this further. Accelerated atherosclerosis is one of the mechanisms affecting vascular health in diabetes mellitus. Several other factors, such as cigarette smoking, could be related to this, but we did not record data. We also do not know the level of glycemic control amongst the patients with diabetes mellitus in the three months preceding AVF surgery.

#### CONCLUSION

Unlike radiocephalic and brachiobasilic AVF, brachiocephalic AVF is associated with higher failure rates among patients with diabetes mellitus. Thus, radiocephalic AVF should preferably be made in such patients, especially if supported by adequate draining vein sizes on pre-operative vessel mapping.

**Conflict of Interest:** None.

#### Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

SU & NI: Data acquisition, critical review, approval of the final version to be published.

SU & ARA: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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