Patency and Complications of Arterio-venous Fistula Created in Pre- and Post-dialysis Settings

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ABSTRACT

Objectives: To determine the difference in patency and complication rates of arterio-venous fistula (AVF) constructed in pre--dialysis *versus* post-dialysis settings.

Study Design: Descriptive study.

Place and Duration of Study: The Department of Vascular Surgery, Shifa International Hospital, Islamabad from January 2014 to August 2020.

Methodology: Computerised record of 726 patients, who had undergone vascular access surgery for haemodialysis, was collected. Patients were divided into two groups according to those who had undergone AVF surgery: a) prior to the commencement; or b) after the commencement of haemodialysis. Primary and secondary patency rates were determined clinically by using duplex scans. Complications and suitability of AV fistula were assessed in both the groups. Data was collected and analysed using SPSS version 25, considering p-value of less than 0.05 as statistically significant.

Results: Early fistula failure was significantly higher in post-dialysis group compared with pre-dialysis group, while primary patency was higher in pre-dialysis (78.2%) group comparing with post-dialysis (66.1%) group. Secondary patency was 88.9% and 75.8% in pre- and post-dialysis groups, respectively. Early dialysis suitability failure rates were 12.2% and 15.1%; and late suitability failure rates were 7.9% and 16.1% in the pre- and post-dialysis groups, respectively. Higher rates of complications like maturation failure, low flow AVF, stenosis, thrombosis, venous hypertension, AV aneurysm, and infections were encountered in post-dialysis group compared to pre-dialysis group.

Conclusion: Surgical creation of AVF three months prior to commencement of haemodialysis is advantageous in terms of patient outcomes and healthcare resources. However, a multidisciplinary approach and timely referral of patients to a vascular clinic further enhances the outcome with respect to the suitability of vascular access for dialysis.

Key Words: *Arterio-venous fistula, Dialysis, Patency, Complications, Suitability.*

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INTRODUCTION

Since haemodialysis was established as a renal replacement therapy, the vascular access as essential pre-requisite of dialysis has been transformed to meet the emerging requirements. Number of patients with end-stage renal disease (ESRD) are rising globally; and those on haemodialysis programme require durable, safe and easily maintainable vascular access. Currently, arterio-venous fistula (AVF) became the gold standard vascular access; and is reverberated in the kidney disease outcomes and quality initiative (KDOQI) guidelines.[1]

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Autologous arterio- venous fistula creation is the first choice vascular access for all patients, who are undergoing haemodialysis.[2] The recommended sites for arterio-venous fistula are, radio-cephalic, followed by brachio-cephalic and basilica-vein transposition (BVT) in the same order; and preferably should be created in the non-dominant arm. In case all autologous sites are exhausted, a bridge graft and tunnelled dialysis catheters could be the last option. The main drawbacks of AVF are: nonavailability for immediate use, the need of maturation time, and high rate of primary failure.[3] To improve primary patency, decrease late dysfunction and reduce complications related to AVF, an appropriate referral, timely intervention, and follow-up are mandatory.[4] Its use is, however, limited due to its early or prolonged dysfunction.

Numerous AVFs are surgically created daily in Pakistan to meet the increasing demand of the patients with ESRD. However, there is no national guidelines for the timing of AVF creation. In Academic Vascular Surgical Unit, the authors also considered the role of multi-disciplinary team[5] and implementation of optimised care to reduce the rate of primary failure and complications related to AVF surgery and its suitability for haemodialysis.

Table I: Complications of AV access.

Complications of AVF	Frequency (%)		p-value
	Group A Pre dialysis (N=442)	Group B Post dialysis (N=284)	
Temporary CVC	1 (0.2)	148 (52.1)	<0.001*
Permanent CVC	43 (9.7)	92 (32.39)	<0.001*
DM	242 (54.75)	160 (56.33)	0.675^
CAD	97 (21.94)	73 (25.70)	0.243^
PVD	53 (11.99)	37 (13.02)	0.679^
HTN	274 (61.99)	176 (61.97)	0.996^
Maturation failure	41 (9.27)	49 (17.25)	0.001*
Low flow AVF	25 (5.65)	26 (9.15)	0.072^
Stenosis	26 (5.88)	31 (10.91)	0.014*
Thrombosis	8 (1.80)	12 (4.22)	0.052^
Dialysis associated steal syndrome (DASS)	26 (5.88)	23 (8.09)	0.245^
Venous hypertension	3 (0.67)	12 (4.22)	0.001*
Aneurysm	7 (1.58)	11 (3.87)	0.053^
Infection	3 (0.67)	3 (1.05)	0.684^[a]
Hematoma	6 (1.35)	4 (1.40)	0.954^
Catheter exit site infection	0 (0)	3 (1.05)	0.059^
Catheter tunnel infections	0 (0)	1 (0.35)	0.212^

** Significant difference between pre- and post-dialysis groups (p <0.05). ^ Not significant (p 0.05), [a] Fisher Exact test.*

The aim of this study was to compare the patency (primary and secondary), suitability of a surgically created AVF for haemodialysis, and the complications related to AVF in patients who underwent AFV surgery before and after the commencement of haemodialysis.

METHODOLOGY

After obtaining the approval from Institutional Review Board (IRB), Shifa International Hospital-Shifa Tameer-e-Millat University, (IRB No. 268-758-2019), the study was conducted at the Department of Vascular Surgery, Shifa International Hospital, Islamabad. This retrospective comparative descriptive study comprised of patients' record from January 2014 to August 2020. Computerised records of 726 patients, who underwent vascular access surgery for haemodialysis, were collected.

The patients were divided into two groups: a) those who had underwent AVF surgery prior to the commencement of haemodialysis; and b) those who had underwent AVF surgery after the commencement of haemodialysis. Primary patency was defined as the interval from time of access placement to any intervention designed to maintain; or re-establish patency and secondary patency was defined as the interval from time of access placement to access abandonment.[4] All patients had a preoperative clinical examination and vein-mapping (duplex scan) of the preserved non-dominant arm selected for vascular access creation. The patients were operated as daycare; and surgery was conducted under local, regional or general anesthesia. Primary vascular access was made by creating a functioning vascular access for the first time.

Inclusion criteria were patients with creatinine more than 4 mg/dl or creatinine clearance less than 25 ml/min, who were on haemodialysis or would require haemodialysis in three months' time. Exclusión criteria were patients who were on haemodialysis, but requiring secondary vascular access, on peritoneal dialysis, not having suitable vein (venous caliber of <2 mm), severe peripheral vascular disease with low flow in the artery (luminal diameter of <1.5 mm), central venous thrombosis, severe upper limb injuries/previous surgeries, and AV malformations (AVMs) on upper limbs.

Frequencies were calculated as valid numbers, and percentages for all variables. Mean and standard deviations were computed for the age variables. The variables were compared among the pre- and post-dialysis groups using Chi-square test / Fisher's Exact test and paired sample 't' test. A p-value of less than 0.05 was considered significant. Confidentiality of patient data was maintained throughout the study. All electronic records and telephonic conversations with the patients were anonymised.

RESULTS

Seven hundred and twenty-six patients, who underwent primary AVF construction without any history of AVF surgery, were enrolled in both the groups from January 2014 to August 2020. Out of total (n=726), 378 (52.1%) were males and 348 (47.9%) were females with mean age of 56.56 years ± SD 16.01. Four hundred and forty-two patients (60.9%) were referred from the Department of Nephrology, Shifa International Hospital, for AVF construction with persistent deterioration of renal functions without prior history of haemodialysis (pre-dialysis group). While 284 (39.1%) patients, presented to vascular clinic for AVF surgery with prior history of haemodialysis for 2-48 weeks (post-dialysis group). Out of those, 149 (52.4%) had temporary double lumen central lines, and 135 (47.5%) had Permacath placed for haemodialysis. Comorbidities were: Diabetes mellitus (n=402 *i.e.*, 55.4%), hypertension (n=450 *i.e.*, 62%), coronary artery disease (n=170 *i.e.*, 23.4%), and mild to moderate peripheral arterial disease (n=90 *i.e.*, 12.4%).

Majority of the patients were right-hand dominant; therefore, the commonest site for AVF was left brachio-cephalic (n=318 *i.e.*, 43.8%), followed by left radio-cephalic (n=256 *i.e.*, 35.3%), right brachio-cephalic (n=43 *i.e.*, 5.9%), brachio-basilic with basilic-vein transposition (BVT) (n=41 *i.e.*, 5.6%), right radio-cephalic (n=34 *i.e.*, 4.7%), and only two (0.3%) patients had ulno-basilic fistula with basilic-vein transposition. After AVF surgery, primary patency was higher in pre-dialysis group (78.2%), comparing with post-dialysis group (66.1%, p = 0.009), irrespective of the type of catheter used for dialysis purposes. Secondary patency was

88.9% and 75.8% in pre-dialysis and post-dialysis groups, respectively ($p < 0.0001$), significantly favouring the pre-dialysis setting of AVF creation. However, early fistula failure (within 24 hours) was significantly higher (n=32, 11.2%) among the post-dialysis group patients. Early dialysis suitability failure rate (unusable within three months) was 12.2% (n=54) and 15.1% (n=43); and late suitability failure (unusable within six months or more) was 7.9% (n=35) and 16.1% (n=46) in the pre- and post-dialysis groups, respectively. Maturation failure was significantly higher in post-dialysis group (Table I). Complications related to fistula surgery, like stenosis at the anastomotic site and ≤5cm centimeters away from the anastomotic site, and 22 more than 5cm centimeters away along the vein distally. All were treated with angioplasty. Low flow issues (9.4%) and stenotic complications (11.1%) were higher among the post-dialysis AVF group patients (Table I). There was no steal syndrome in any of the radio-cephalic AVFs, while 49 of the brachio-cephalic AVFs had dialysis-associated steal syndrome (DASS). Fifteen patients developed arm edema due to central venous stenosis, and were successfully treated by angioplasty. AV aneurysm of the mature vein at dialysis needle prick site was found in 18 patients, and those were treated with excision and inter-positional vein grafts.

DISCUSSION

The incidence of ESRD requiring dialysis has increased in the Asian population from 344 per million in 2002 to 1,831 per million in 2006.[6] The overall chronic kidney disease (CKD) prevalence in the Pakistani adult population was found to be 21.2% with the highest prevalence reported as 29.9% and the lowest being 12.5%.[7] Since the invention of artificial dialysing machine rapid development in the understanding and management of ESRD led to haemodialysis as renal replacement therapy. Patients with ESRD require haemodialysis *via* an AVF until they have the chance for renal transplant. There are more than 20 technical modifications pursuing long-term efficient patency rate, minimising complications and patient's discomforts.[8] Optimal long-term haemodialysis vascular access strategy requires an effective arterio-venous fistula (AVF), while AV graft is reserved for those who do not have suitable vasculature for setting a useful AV fistula.[9] Quinn *et al.* found that the creation of AVF four months before starting haemodialysis was associated with fewer complications like infection and death, than the one created within one month of starting haemodialysis.[10] Prior studies showed important complications of AVF are infection, thrombosis, edema, haematoma, aneurysm, steal syndrome, ischemic neuropathy, stenosis, and congestive heart failure.[11]

Patency rate of more than 70% of AV fistula at one year is acceptable outcome, and the patency rate also depends upon the level of fistula.[12] Secondary patency was described higher in literature in contrast to this study; whereas, primary patency is higher than the secondary patency. Most of the reported fistulae were radio--cephalic; while in this study, brachio-cephalic was the most common type of fistula, which also showed higher patency rate. Though the recommendations are for the orderly placement of vascular access for dialysis, radio-cephalic, brachi-ocephalic, basilica-vein transposition followed by AV graft placement as a last resort,[13] but it was found that patient factors and referral pattern also effected the preference of fistula sites and types in this series. "Fistula-First-Catheter-Last" initiative may not be always a feasible strategy in all cases, depending upon several other factors;[14] including lack of multi-disciplinary approach to the management of end-stage kidney disease (ESKD), patient's preference, comorbidities and referral pattern as seen in this study, where a significant number of patients were referred to vascular clinic, several weeks after the commencement of dialysis, through catheters. Better patency rate, improved suitability for dialysis and fewer complications were found in AFV created prior to commencement of dialysis compared to those who remained on dialysis through central venous catheter and then referred for AVF surgery.[15] Age of the patient and comorbidities, particularly cardiovascular and metabolic diseases, contribute in fistula maturation failure and suitability-failure for dialysis.[16] Dialysis-related complications and mortality is higher in elderly patients compared to younger population with similar comorbidities and clinical situation.[17] It was found that fistula maturation failure was higher in patients with multiple comorbidities but no definite age-related factors contributing in fistula success rate were discovered in this study.

This could be due to relatively younger patient population in this study compared to the literature.

A systematic, coordinated and multi-disciplinary approach is required for all patients requiring hemodialysis as renal replacement therapy. This study accomplished significant benefits in terms of success in fistula surgery, primary and secondary patency, and longer suitability of AVF for dialysis, in patients undergoing fistula surgery prior to commencement of dialysis comparing with those who undergo surgery after being dialysed through central venous catheters, and thereafter referred for access surgery. This study concludes the requirement for reorganisation of renal replacement therapy services to achieve better patient and healthcare outcomes.

Creation of AVF, 3-6 months prior to commencement of hemodialysis, is advantageous in terms of patient outcomes and healthcare resources management.[18] Potential candidates for haemodialysis should be referred to vascular surgery for timely decision-making. Renal replacement therapy should be decided by a multi-disciplinary team, comprising of all inter-related specialists, including the primary care physicians.[19] Based on further studies, at other large centres and taking into consideration available literature, guidelines should be framed to streamline AVF surgery strategy to avoid clinical unpredictability. Recommendations based upon several studies coincide with the findings of the present authors that fistula created before the initiation of dialysis has superior patency, fewer complications, and fewer re-interventions leading to improve patient outcomes in term of survival.[20] This strategy also saves healthcare resources and is cost-effective for the patients and families.

CONCLUSION

Surgical creation of AVF three months prior to commencement of haemodialysis is advantageous in terms of patient outcomes

and healthcare resources. However, a multi-disciplinary approach and timely referral of patients to a vascular clinic further enhances the outcomes with respect to suitability of vascular access for dialysis.

PATIENTS' CONSENT:
Since it was a retrospective study, so patients' consents have been waived.

ETHICAL APPROVAL:
Ethical approval was obtained from the Institutional Review Board (IRB), Shifa Tameer-e-Millat University, Islamabad (IRB No. 268-758-2019).

CONFLICT OF INTEREST:
The authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:
SMA: Collected data, designed manuscript and conducted statistical analyses.
OE: Conceived the idea and helped in designing the study.
MIK: Conceived study, wrote the manuscript, reviewed and approved the manuscript.

REFERENCES

1. Lok CE, Moist L. KDOQI 2019 vascular access guidelines: What is new? *Adv Chronic Kidney Dis* 2020; **27(3)**:171-6. doi: 10.1053/j.ackd.2020.02.003.
2. National kidney foundation kidney disease outcomes and quality initiative (K/DOQI), 2006 update. National kidney foundation, Inc.
3. Li Y, Cui W, Wang J, Zhang C, Luo T. Factors influencing AVF dysfunction in patients with maintenance haemodialysis: A retrospective study. *Ann Palliat Med* 2021; **10(4)**:4047-54. doi: 10.21037/apm-20-2196.
4. Lok CE, Allon M, Moist L, Oliver MJ, Shah H, Zimmerman D. Risk equation determining unsuccessful cannulation events and failure to maturation in arteriovenous fistulas. *J Am Soc Nephrol* 2006; **17(11)**:3204-12. doi: 10.1681/ASN.2006030190.
5. Flu H, Breslau PJ, Krol-van Straaten JM, Hamming JF, Lardenoye JW. The effect of implementation of an optimised care protocol on the outcome of arteriovenous haemodialysis access surgery. *J Vasc Surg* 2008; **48(3)**: 659-68. doi: 10.1016/j.jvs.2008.04.002.
6. Jeong S, Kwon H, Chang JW, Kim MJ, Ganbold K, Han Y, *et al.* Patency rates of arteriovenous fistulas created before *versus* after hemodialysis initiation. *PLoS ONE* **14(1)**:e0211296. doi: 10.1371/journal.pone.0211296.
7. Nawaz S, Ali S, Shahzad I, Baloch MU. Arterio venous fistula experience at a tertiary care hospital in Pakistan. *Pak J Med Sci* 2013; **29(1)**:161-5. doi:10.12669/pjms.291.2753.
8. KDOQI. Clinical practice guidelines and clinical practice recommendations for vascular access. *Am J Kidney Dis* 2006; **48(Suppl 1)**:S176–247. doi: 10.1053/j.ajkd.2006.04.029.
9. Jafar TH, Schmid CH, Levey AS. Serum creatinine as marker of kidney function in south Asians: A study of reduced GFR in adults in Pakistan. *J Am Soc Nephrol* 2005; **16(5)**:1413-9. doi: 10.1681/ASN.2004121100.
10. Quinn RR, Oliver MJ, Devoe D, Poinen K, Kabani R, Kamar F, *et al.* The effect of predialysis fistula attempt on risk of all-cause and access-related death. *J Am Soc Nephrol* 2017; **28(2)**:613-20. doi: 10.1681/ASN.2016020151.
11. Pey See Y, Cho Y, Pascoe EM, Cass A, Irish A, Voss D, *et al.* Predictors of arteriovenous fistula failure: A post hoc analysis of the favoured study collaborative group. *Kidney* 360 2020; **1(11)**:1259-69. doi:10.34067/KID.0002732020.
12. Lee T. Fistula first initiative: historical impact on vascular access practice patterns and influence on future vascular access care. *Cardiovasc Eng Technol* 2017; **8(3)**:244-54. doi: 10.1007/s13239-017-0319-9.
13. Allon M. Vascular access for hemodialysis patients: New data should guide decision making. *Clin J Am Soc Nephrol* 2019; **14(6)**:954-61. doi: 10.2215/CJN.00490119.
14. Lee SD, Xiang J, Kshirsagar AV, Steffick D, Saran R, Wang V. Supply and distribution of vascular access physicians in the United States: A cross-sectional study. *Kidney360* 2020; **1(8)**:763-71. doi: 10.34067/kid.0002722020
15. Lok CE. Fistula first initiative: Advantages and pitfalls. *Clin J Am Soc Nephrol* 2007; **2(5)**:10433. doi: 10.2215/CJN.01080307.
16. Singh P, Germain MJ, Cohen L, Unruh M. The elderly patient on dialysis: Geriatric considerations. *Nephrol Dial Transplant* 2014; **29(5)**:990-6. doi: 10.1093/ndt/gft246.
17. Gaipov A, Issanov A, Kadyrzhanuly K, Galiyeva D, Khvan M, Aljofan M, *et al.* Epidemiology of dialysis-treated end-stage renal disease patients in Kazakhstan: Data from nationwide large-scale registry 2014–2018. *BMC Nephrol* 2020; **21(1)**:407. doi: 10.1186/s12882-020-02047-6.
18. Wongmahisorn Y. Development and validation of a clinical score to predict 1-year survival of arteriovenous fistula access: A diagnostic study. *Ann Surg Treat Res* 2020; **98(1)**:44-50. doi: 10.4174/astr.2020.98.1.44.
19. Woodside KJ, Bell S, Mukhopadhyay P, Repeck KJ, Robinson IT, Eckard AR, *et al*. Arteriovenous fistula maturation in prevalent hemodialysis patients in the United States: A national study. *Am J Kidney Dis* 2018; **71(6)**:793-801. doi: 10.1053/j.ajkd.2017.11.020.
20. Farrington CA, Robbin ML, Lee T, Barker-Finkel J, Allon M. Early predictors of arteriovenous fistula maturation: A novel perspective on an enduring problem. *J Am Soc Nephrol* 2020; **31(7)**:1617-27. doi: 10.1681/ASN.2019080848.