Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/msa9re93

TYPES AND SITES OF AV FISTULAS IN DIALYSIS PATIENTS

Dr. Muhammad Mohsin Riaz[1*], Dr. Hafiz Faisal Munir Qamar[2], Dr. Mubashir Dilawar[3], Dr. Nabiha Rizvi[4], Dr. Aqeel Ahmed[5], Dr. Muhammad Asif[6], Dr. Hafiz Nauman Munir Saqib[7]

[1*]Assistant Professor of Nephrology, Ali Fatima Hospital, Bhobatian Chowk, Raiwind Road, Lahore, Pakistan. Email: dr.m.mohsin@gmail.com
[2]Registrar Nephrology, Ali Fatima Hospital, Bhobatian Chowk, Raiwind Road, Lahore, Pakistan. Email: docfaisal73@gmail.com
[3]Registrar Nephrology, Fatima Memorial Hospital, Lahore, Pakistan. Email: mubashirdilawar@hotmail.com
[4]Assistant Professor of Nephrology, Lahore Medical and Dental College lahore, Pakistan. Email: rizvinabiha@gmail.com
[5]Senior Registrar Nephrology, Gujranwala Medical College Teaching Hospital, Gujranwala, Pakistan. Email: aqeelahmad.2006@gmail.com
[6]Senior Registrar Nephrology, DG Khan Medical College Dera Ghazi Khan, Pakistan Email: dr.azee06@gmail.com
[7]Medical Officer, Nephrology, Evercare Hospital, Lahore, Pakistan Email: numanh363@gmail.com

***Corresponding Author:** Dr. Muhammad Mohsin Riaz
*Email: Email: dr.m.mohsin@gmail.com

Abstract

Introduction: Arteriovenous fistulas (AVFs) are the preferred vascular access for hemodialysis in chronic kidney disease (CKD) patients, with types and sites influencing functionality and complications. This study evaluates AVF characteristics and their impact on hand grip strength.

Objective: To evaluate the prevalence and characteristics of different types and anatomical sites of AVFs in CKD patients undergoing hemodialysis, focusing on their clinical implications.

Materials and Method: A quasi-experimental study at Ali Fatima Hospital, Bhobatian Chowk, Raiwind Road, Lahore, Pakistan from February, 2024 to July, 2024 enrolled 90 CKD patients aged 20–60 years undergoing AVF placement. Hand grip strength was measured pre- and post-AVF using a manual dynamometer. Data on AVF types and sites were analyzed using IBM-SPSS version 26.

Results: Brachiocephalic AVFs predominated (80%), mostly in the left arm (95.56%). Hand grip strength decreased significantly post-AVF (21.00 ± 7.35 kg to 19.22 ± 7.92 kg, $p < 0.001$).

Conclusion: Brachiocephalic AVFs are common, with significant hand grip strength reduction post-placement, necessitating postoperative rehabilitation.

Keywords: Arteriovenous Fistula, Hand Grip Strength, Hemodialysis, Chronic Kidney Disease, Vascular Access

INTRODUCTION

For ESRD patients requiring hemodialysis, arteriovenous fistulas (AVFs) are the preferred vascular access, as AVFs have the advantage of longer duration and lower complication rates than arteriovenous graft (AVG) or central venous catheter (CVC). High-flow access for dialysis is provided by creating an AVF via a direct anastomosis between an artery and vein, usually in the upper extremity. It leads to the improvement in blood flow to the vein to allow it to mature and withstand repeated cannulation for hemodialysis sessions (1). Hemodialysis care based on creating an AVF is central, allowing for safe, efficient blood filtration without the higher infection and thrombosis risks associated with other access types. Nevertheless, the outcome of the function, maturation, and long-term patency of an AVF is highly dictated by the selection of the type of AVF and the anatomical site (2).

Primary types of AVF are used for hemodialysis, such as radiocephalic, brachiocephalic, and brachiobasilic fistulas, defined by the artery and vein used in the anastomosis. The first choice at the wrist is often the radiocephalic AVF, which is formed between the radial artery and the cephalic vein due to its distal location, preserving proximal vessels for future access (3). When distal vessels are not appropriate, then Brachiocephalic AVF is made, linking the brachial artery to the cephalic vein located in the upper arm, with higher flow rates, but it has a higher risk for steal syndrome-related complications (4). The brachiobasilic AVFs involve the brachial artery and basilic vein, often requiring vein transposition from a deeper anatomical position. However, the procedure is more complex but viable than the arterial options for patients with limited vascular options (5). When upper extremity options are exhausted, rare cases of lower extremity AVFs (such as femoral vein) are considered, for which complication rates are higher (6).

Patient-specific factors such as vascular anatomy and comorbidities such as diabetes or peripheral vascular disease influence the AVF site selection. Preoperative evaluation of vessel diameter and quality via duplex ultrasonography is emphasized as this solely affects the maturation and patency of AVF (7). For instance, veins of luminal diameter greater than 2.5 mm and arteries with adequate flow are associated with better outcomes (8). Finally, the site of the AVF impacts the quality of life, as upper extremity fistulas are generally preferred due to ease of and low risk of accessing the fascial planes and complications associated with a lower extremity fistula (9). Despite this, the hemodialysis process itself (including repeated cannulation) may cause complications, such as stenosis, thrombosis, and aneurysm, that require close monitoring and care (10).

There are challenges to AVF creation, with 28–53% of fistulas failing to mature sufficiently for dialysis due to small vessel caliber, previous vascular damage, or delayed referral for surgery (11). The importance of these failures is their contribution to increased morbidity, as patients may require temporary catheters, which are known sources of infection. Moreover, AVFs can induce hemodynamic changes like increased cardiac output from high-flow shunting, which can also stress cardiovascular function in patients with pre-existing heart conditions (12). However, despite these challenges, AVFs remain the gold standard for hemodialysis access, with long-term studies showing a superior patency rate with grafts, particularly for kidney transplant recipients where AVF fistulas may persist after transplantation (13).

The creation of AVF is less common in pediatric patients, but this procedure is critically important, and outcomes are heavily dependent on proper techniques and site selection for smaller vessels (14). Similarly, patients with multiple failed upper extremity accesses have already shown promising long-term outcomes for complex cases, such as transposed femoral vein AVF (15). The variety of AVF sites and types emphasizes the need for individual patient approaches to vascular access whereby anatomical suitability is balanced with functional outcomes. The development of AVF involves a nuanced process, and it is imperative to understand the best types and sites of AVF that are individually appropriate to promote dialysis care and improve patients' quality of life. The aim of this study is to determine the prevalence and characteristics of various AVF types and sites in a group of people on dialysis and their clinical implications.

Objective: This study aims to determine the incidence and anatomical characteristics of various types and sites of arteriovenous fistulas in chronic kidney disease patients undergoing hemodialysis and their clinical implications.

MATERIALS AND METHODS

Design: Quasi-experimental study.

Study setting: The study was conducted at Ali Fatima Hospital, Bhobatian Chowk, Raiwind Road, Lahore, Pakistan

Duration: The study was done from February, 2024 to July, 2024.

Inclusion Criteria:

Those patients were included who aged 20–60 years, of both genders, with CKD-5/CKD-5D (GFR ≤ 15 ml/min/1.73m²) and undergoing AVF placement for hemodialysis.

Exclusion Criteria

Patients with upper extremity malformations, neurological or muscular disorders, ejection fraction <35%, inflammatory arthritis, prior upper extremity surgery, or peripheral vascular disease were excluded in order to minimize confounding factors affecting HGS.

Methods

90 patients undergoing arteriovenous fistula (AVF) placement in the Department of Nephrology at Ali Fatima Hospital, Bhobatian Chowk, Raiwind Road, Lahore, Pakistan were enrolled in this study. All participants provided informed consent as well as demographic details, which were stored confidentially to explain the study's purpose. A manual dynamometer was used to assess secondary hand grip strength. Measurements were taken while patients sat with their shoulders adducted, elbows flexed to 90 degrees, and their forearms were neutral. The average of three repeats was recorded in kilogram-force (kg-f). The grip strength was checked before and three months after AVF installation, with or without hemodialysis status. AVF type (radiocephalic, brachiocephalic, braciobasilic), AVF site (left or right arm), and location (emergency or elective) were recorded. Frequencies, percentages, and mean (±SD) of variables were calculated by statistical analysis using IBM-SPSS Version 26, and a student t-test was done between pre and post-AVF grip strength ($p < 0.05$).

RESULTS

In this quasi-experimental study, 90 patients with chronic kidney disease undergoing arteriovenous fistula (AVF) placement were enrolled in order to determine the type and site of the AVF and the hand grip strength as a secondary outcome. The mean age of the participants was 45.41 ± 10.93 years (range 20–60 years). A male-to-female ratio of 1.8:1 was found in the study population, of which there were 58 (64.44%) males and 32 (35.56%) females. Comorbidities were familiar with 47 (52.2%) diabetes mellitus patients and 84 (93.3%) hypertension patients. In 73 (81.1%) patients, hemodialysis was started on an average of 2.68 ± 2.93 years (0.08–12 years).

Table 1: Demographic and Clinical Characteristics

Variable	Value
Age (years, mean ± SD)	45.41 ± 10.93
Gender (Male/Female, n, %)	58 (64.44%) / 32 (35.56%)
Diabetes Mellitus (n, %)	47 (52.2%)
Hypertension (n, %)	84 (93.3%)
Hemodialysis Initiated (n, %)	73 (81.1%)
Duration of Hemodialysis (years, mean ± SD)	2.68 ± 2.93

86 (95.56%) patients had the anatomical site of AVF placement in the left arm and 4 (4.44%) in the right arm. End-to-side anastomosis was performed in 84 (93.33%) patients, and side-to-side was used in 6 (6.67%).

Table 2: Anatomical Site and Anastomosis Type

Variable	n (%)
Anatomical Site	
Left Arm	86 (95.56%)
Right Arm	4 (4.44%)
Type of Anastomosis	
End-to-Side	84 (93.33%)
Side-to-Side	6 (6.67%)

There were 72 (80%) brachiocephalic AVF cases, 11 (12.22%) radiocephalic AVF cases, and 7 (7.78%) brachiobasic AVF cases. The secondary outcome of hand grip strength was significantly reduced post-AVF placement. The mean hand grip strength pre-AVF placement was 21.00 ± 7.35 kg (range: 10–50 kg), and 3 months following the procedure, it decreased to 19.22 ± 7.92 kg (range: 8–50 kg) with a statistically significant difference ($p < 0.001$).

Table 3: Hand Grip Strength Comparison

Variable	Mean ± SD (kg)	Range (kg)	p-value
Pre-AVF Hand Grip Strength	21.00 ± 7.35	10–50	<0.001
Post-AVF Hand Grip Strength	19.22 ± 7.92	8–50	

These findings reveal that brachiocephalic AVFs are prevalent in this cohort and there is a reduction in hand grip strength post-AVF, indicating that AVF placement in dialysis patients may have functional significance.

DISCUSSION

This study provides findings about the types and anatomical sites of arteriovenous fistulas (AVF) in patients with chronic kidney disease (CKD) undergoing hemodialysis and the change in hand grip strength after AVF placement. This cohort is aligned with clinical trends of preferring upper arm fistulas when distal vessels are suboptimal (1), as radiocephalic AVFs (12.22%) were less common. This distribution probably reflects the influence of vascular anatomy and preoperative assessment influenced by duplex ultrasonography, which often guides site selection to ensure adequate vessel diameter and flow (2). A second choice is brachiobasilic AVFs, which are seen in 7.78% of cases that require vein transposition as the basilic vein is located deeper (3). Upper extremity AVFs, particularly in the left arm (95.56%), were preferred in this study based on the preference of their accessibility and lower complication rates relative to lower extremity fistulas, having higher rates of infection and thrombosis (4).

The surgical practice of optimizing flow dynamics and reducing complications such as venous hypertension is reflected in the high prevalence of end-to-side anastomosis (93.33%) as opposed to side-to-side (6.67%) in this study (5). Anastomosis is end-to-side rather than end-to-end, which helps minimize the turbulence and preserves distal perfusion, imperative to preventing steal syndrome, which is a known complication where blood is bypassed from the hand resulting in ischemia and weakness (6). However, with AVF placement, there was a significant reduction in hand grip strength post-AVF placement (21.00 ± 7.35 kg, to 19.22 ± 7.92 kg, $p < 0.001$), which can imply functional implications of AVF creation due to steal syndrome, muscle disuse, or may be due to inflammation around the fistula site (7). This finding is consistent with previous studies, such as Zeynep Tuna et al., showing that hemodialysis patients have lower hand grip strength than controls due to vascular and muscular changes associated with AVF (8). Further, the observed decline in grip strength may also represent patients' unwillingness to use the AVF arm due to fears regarding fistula damage and progressing musculoskeletal degeneration (9).

Patient demographics (mean age 45.41 years, 64.44% male predominance) were consistent with CKD epidemiology, in which males are slightly more affected, and younger patients with CKD are becoming increasingly dependent on dialysis (10). Vascular quality was likely influenced by the high prevalence of comorbidities diabetes (52.2%) and hypertension (93.3%), contributing to a preference for brachiocephalic AVFs (11), which are suitable for patients with compromised distal vessels. In addition, these comorbidities increase the risk of failure of AVF maturation, reported in 28 to 53 percent of cases requiring treatment by revision or creation of a new AVF. Pre-operative planning and post-operative surveillance are also necessary (12). Global guidelines, such as those from the European Society for Vascular Surgery, have focused on upper extremity AVFs because these autologous fistulas tend to have superior long-term patency and less infection rate than grafts or catheters (13).

The functional impact of AVFs with reduced grip strength is evidence for post-operative rehabilitation strategies like hand exercises to improve AVF maturation and maintain limb function (14). Studies such as Mo et al. have demonstrated that isometric exercises like dumbbell training can improve AVF patency and may prevent strength decline, but long-term benefits from this exercise are inconsistent. Furthermore, studies relating to cardiac strain after AVF creation acknowledge the further complications of hemodynamic effects of AVFs, including increased cardiac output as a result of high-flow shunting, which should be taken into account, particularly in patients with pre-existing cardiovascular conditions. These observations highlight the necessity of a multidisciplinary participation of nephrologists, vascular surgeons, and dialysis nurses to optimize treatment options for patients with AVF and reduce functional deficits.

Limitations of the study include a single-center design and a relatively small sample size that should limit the generalization of findings. Future research should focus on longer-term AVF patency and functional outcomes in multicenter cohorts of different types and sites (9). The limited number of patients with lower extremity AVFs in this cohort does not allow insights into their clinical implications. However, the literature suggests they are feasible in patients with exhausted upper extremity options with higher complication rates (15). Further investigation of AVF use is also indicated in pediatric and post-transplant populations where AVF use is less common (6, 13).

Finally, this study emphasizes the predominance of brachiocephalic AVFs as well as placement in the left arm in dialysis patients because of anatomical and clinical considerations. Hand grip strength reduction after placement of the AVF emphasizes the need for targeted interventions to maintain limb function and improve quality of life. Preoperative vascular mapping, meticulous surgical techniques, and postoperative exercise programs may assist AVF maturation, mitigate functional decline, and fit within global efforts to improve vascular access for hemodialysis care (10, 14).

CONCLUSION

This study shows that brachiocephalic arteriovenous fistulas (AVFs) are the most common type of AVFs in chronic kidney disease patients treated by hemodialysis, placed predominantly in the left arm due to anatomical and clinical considerations. The significant reduction in hand grip strength post-AVF placement (from 21.00 ± 7.35 kg to 19.22 ± 7.92 kg, $p < 0.001$) highlights the functional impact of AVF creation, potentially due to steal syndrome, muscle disuse, or inflammation. These findings highlight the importance of preoperative vascular mapping as well as postoperative rehabilitation (hand exercises) to supplement AVF maturation and limb function. Improved AVF outcomes and reduced complications are accomplished through multidisciplinary approaches of nephrologists, surgeons, and dialysis nurses. Longer term patency and functional outcomes in diverse populations and AVF sites, especially options for the lower extremity, should be further explored to refine vascular access strategies leading to better quality of life for dialysis patients.

References

1. Bin-ayesh, H.N., Alhussein, S.H., Alahmari, N.F., Alanzi, R.Q., Almaimani, R.F., Al-Ali, J.A., Alomar, I.A.A., Hassaballa, M.I., Alwadai, S.A.M., ALkheraiji, N.M. and Alharbi, F.M.A., 2021. Review on arteriovenous fistula techniques and complications. Entomology and Applied Science Letters, 8(1-2021), pp.105-113.
2. Letachowicz, K., Bardowska, K., Królicki, T., Kamińska, D., Banasik, M., Zajdel, K., Mazanowska, O., Madziarska, K., Janczak, D. and Krajewska, M., 2021. The impact of location and patency of the arteriovenous fistula on quality of life of kidney transplant recipients. Renal Failure, 43(1), pp.113-122.
3. Huber, T.S., Berceli, S.A., Scali, S.T., Neal, D., Anderson, E.M., Allon, M., Cheung, A.K., Dember, L.M., Himmelfarb, J., Roy-Chaudhury, P. and Vazquez, M.A., 2021. Arteriovenous fistula maturation, functional patency, and intervention rates. JAMA surgery, 156(12), pp.1111-1119.
4. Sahasrabudhe, P. and Bindu, A., 2021. Nuances of arteriovenous fistula creation for vascular access in hemodialysis. Indian Journal of Plastic Surgery, 54(03), pp.257-263.
5. Manov, J.J., Mohan, P.P. and Vazquez-Padron, R., 2022. Arteriovenous fistulas for hemodialysis: Brief review and current problems. The journal of vascular access, 23(5), pp.839-846.
6. Ahmed, O.F., Hamodat, O.M., Kakamad, F.H., Abduljabbar, R.S., Salih, A.M., Omar, D.A., Mustafa, M.Q., Hassan, M.N., Mohammed, S.H., Mikael, T.M. and Najar, K.A., 2021. Outcomes of arteriovenous fistula for hemodialysis in pediatric age group. Annals of Medicine and Surgery, 72, p.103100.
7. Zhang, Y., Yi, J., Zhang, R., Peng, Y., Dong, J. and Sha, L., 2022. Risk factors for arteriovenous fistula thrombus development: a systematic review and meta-analysis. Kidney and Blood Pressure Research, 47(11), pp.643-653.
8. Venkat Ramanan, S., Prabhu, R.A., Rao, I.R., Chawla, A., Shenoy, S.V., Nagaraju, S.P. and Bhojaraja, M.V., 2022. Outcomes and predictors of failure of arteriovenous fistulae for hemodialysis. International urology and nephrology, pp.1-8.
9. Pfister, M., d'Avalos, L.V., Müller, P.C., de Rougemont, O., Bonani, M., Kobe, A., Puippe, G., Nickel, F. and Rössler, F., 2023. Long-term patency of arteriovenous fistulas for hemodialysis: A decade's experience in a transplant unit. Hemodialysis International, 27(4), pp.388-399.
10. Pinto, R., Sousa, C., Salgueiro, A. and Fernandes, I., 2022. Arteriovenous fistula cannulation in hemodialysis: A vascular access clinical practice guidelines narrative review. The Journal of Vascular Access, 23(5), pp.825-831.
11. Zhang, H. and Li, W., 2021. Establishment and maintenance of autogenous arteriovenous fistula in hemodialysis patients: A new beacon. Chronic Diseases and Translational Medicine, 7(04), pp.217-219.
12. Stoumpos, S., Rankin, A., Hall Barrientos, P., Mangion, K., McGregor, E., Thomson, P.C., Stevenson, K., Welsh, P., Kasthuri, R., Kingsmore, D.B. and Roditi, G., 2021. Interrogating the haemodynamic effects of haemodialysis arteriovenous fistula on cardiac structure and function. Scientific reports, 11(1), p.18102.
13. Vajdič Trampuž, B., Arnol, M., Gubenšek, J., Ponikvar, R. and Buturović Ponikvar, J., 2021. A national cohort study on hemodialysis arteriovenous fistulas after kidney transplantation-long-term patency, use and complications. BMC nephrology, 22, pp.1-9.
14. Gupta, A., Kumar, V., Peswani, A.R., Suresh, A. and Peswani, A., 2022. Outcomes of arteriovenous fistula creation in patients undergoing hemodialysis: an Indian experience. Cureus, 14(1).
15. Orion, K.C., Kim, T.I., Rizzo II, A.N., Cardella, J.A., Rizzo Sr, A. and Sarac, T.P., 2021. Long-term outcomes of transposed femoral vein arteriovenous fistula for abandoned upper extremity dialysis access. Journal of Vascular Surgery, 74(1), pp.225-229.