

Complications of arteriovenous fistula in dialysis patients: Incidence and risk factors in Taif city, KSA

Majed Mansour Aljuaid¹, Nawaf Najim Alzahrani¹,
Abdulrahman Abdulaziz Alshehri¹, Lama Humaied Alkhaldi¹,
Faisal Sultan Alosaimi¹, Nawwaf Waiel Aljuaid¹, Omar Ahmed Asiri¹,
Ayman Ahmad Atalla²

¹College of Medicine, Taif University, ²Department of Family Medicine, College of Medicine, Taif University, Saudi Arabia

ABSTRACT

Aim: The aim of this study was to measure the prevalence of arteriovenous fistula (AVF) and its complications in patients undergoing hemodialysis (HD) in Taif Region, Saudi Arabia. **Methods:** This was a prospective hospital-based study conducted on 196 patients aged above 18 years who were undergoing dialysis in two hospital Taif City. Data collected and documented using a pretested questionnaire, which included sociodemographic details and also information about fistula-related complications. Hospital records were also reviewed to match the complication and related risk factors. Appropriate statistical tests were used and analyzed with SPSS software ver. 23. **Results:** Majority of the study patients were in the age group of 41–60 years and the prevalence in male and female were 49.5% and 50.5%, respectively. The most prevalent chronic illness in the patients was hypertension (41.7%) and more than 30.6% had multiple chronic illness. The most common type of AVF was radiocephalic fistula (RCF). The most common complication associated with the patients with AVF was ischemic neuropathy (29.6%). Smokers had significant history of myocardial infarction than non smokers. **Conclusion:** Early and timely detection of complications in AVF is essential for proper management. Health professional should have thorough knowledge regarding the complications related to AVF. Early diagnosis and appropriate treatment are essential to improve the quality of life in patients on HD.

Keywords: Arteriovenous, complications, dialysis, fistula, incidence, Taif

Introduction

Hemodialysis (HD) is considered and accepted to be temporary treatment for patients with end stage renal disease (ESRD) awaiting renal transplantation. Repeated access to the circulation is essential to perform adequate maintenance HD.^[1] Many patients who are not candidates for renal transplantation or those for whom a compatible donor cannot be secured are dependent on HD for their lifetime. This situation results in the long-term

need for and use of dialysis access. There are a lot of short and long-term complications that may interfere with the functioning of the dialysis.^[2]

The relative less availability of kidney donors and the increased survival of patients mean that most will require a prolonged period of artificial renal support, necessitating the formation of arteriovenous fistulas (AVFs). HD fistulas are surgically created communications between the native artery and vein in an extremity. AVF is an autologous arteriovenous access created by a connection of a vein to an artery (e.g. cephalic vein joined to radial artery) where the vein serves as the accessible conduit.^[3]

Address for correspondence: Dr. Nawaf Najim Alzahrani, Medical Student, College of Medicine, Taif University, Taif City, Abubakr Street, Saudi Arabia.
E-mail: inawaf_zz@live.com

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Polytetrafluoroethylene (PTFE) and other materials (dacron, polyurethane, bovine vessels, saphenous veins) are used or have been used as a communication medium between the artery and the vein and are termed prosthetic HD access arteriovenous grafts (AVGs). The access that is created is routinely used for HD 2–5 times per week. Overall complication rates of AVFs are low typically, 0–16%. Complications include arterial emboli (1–7%); post-percutaneous transluminal angioplasty (PTA) flow-compromising ruptures (2–5%); the rate can be higher in native fistulas of upper arm [15%]; fluid overload or pulmonary edema; reactions to the contrast agent; extravasation hematomas at puncture sites of previous dialysis procedures; infection; and death (very rare). Death may result from cardiac arrhythmia, pulmonary edema, or a reaction to the contrast medium. Although clots may migrate into pulmonary circulation, clinically evident pulmonary embolism has been reported in only six cases; however, pulmonary embolism may occur with native fistulas. This complication is extremely rare during thrombolysis of HD access grafts.^[4-6]

The Primary fistulas suggested in AVF include: (i) RCF, (ii) brachiocephalic fistula, (BCF) and (iii) basilic vein transposition (brachial-basilic) fistula. A major problem with AVFs is the high frequency of primary failures, either due to lack of maturation or early thrombosis. In cases of failure of an AVF created, secondary fistulas are constructed by utilizing the conversion of an arterialized outflow vein to a direct or transposed AVF.^[7]

In some cases of diabetes mellitus (DM), heart failure, peripheral vascular disease, obesity or elderly patients, insertion of AVF is difficult or contraindicated.^[8]

Studies have found that fistula complications are associated with morbidity, mortality, and a high economic burden.^[9,10] And it was reported that early detection and treatment of these complications can prevent more severe conditions and consequently save additional costs and reduce hospitalization periods.^[11]

In the Kingdom of Saudi Arabia, there is lack of data regarding the complications prevalent in patients who underwent AVFs. Hence, the main aim of this study was to measure the prevalence of AVF in patients on HD and its complications in patients undergoing HD with AVF in Taif Region, Saudi Arabia. The study also looked for any predisposing risk factors to the complications of AVF to prevent or minimize them in the future.

Subjects and Methods

This was a hospital-based prospective study done in 196 patients undergoing HD with AVF in two hospitals (King Abdulaziz Specialist Hospital and Prince Mansour Armed Forces Hospital in Taif city). The study was conducted during the period of December 2017 to December 2018. Data collection was carried out using a pretested questionnaire. The validity and internal

consistency reliability of the questionnaire was measured. A Cronbach's alpha value of $r = 0.854$ was achieved.

All patients underwent detailed history taking, and data were collected on age, sex, and cardiovascular risk factors such as DM and hypertension (HTN). Patients were further evaluated using clinical examinations and reviewed by hospital records.

Inclusion criteria

All the patients who is undergoing HD with AVF and who gave consent to participate in the study. Participants were informed about the anonymity and confidentiality of the data/information they report in the questionnaire. Only people who aged above 18 years were included.

Exclusion criteria

Patients who did not give consent were excluded from our study. Also, patients treated or consulted in other departments and whose age was less than 18 years were also excluded from our study.

Ethical confederations

The Research Ethics Committee of Taif University approved the study ethical committee of Directorate of health affairs, ministry of health, Taif city on the 26th of June, 2018. Written and verbal consents were obtained from participant patients.

Data analysis

All the data collected were tabulated using MS Excel and statistical analysis was done using SPSS version 23. Descriptive statistics were used, with continuous variables expressed as mean \pm SD and categorical data expressed as percentages. Pearson Chi-square test was applied to assess the statistical association of one variable with another. A *P* value of less 0.05 was considered statistically significant.

Results

Our study was a cross-sectional 1-year prospective study which was done on 196 patients undergoing HD with AVF. The age wise distribution of participants is depicted in [Table 1].

In our study, we included both genders, of which we had 49.5% males and 50.5% females. When the causes of doing dialysis were assessed, 49 (25%) patients did it because of renal failure, 47 (24%) did it due to "hypertension," and DM was the cause for 6.6% of the patients. The detailed causes of dialysis are depicted in [Table 2].

According to the history of the prevalence of chronic illness among the participants, HTN was present in 79 (40.3%) and asthma was seen in 3 (3.6%), 7 (1.5%) reported to have DM, 1 (0.5%) had hyperthyroidism, 1 (0.5%) had SLE, 60 (30.6%) participants reported that they had multiple illness, and 45 (23%) reported having no chronic illness.

Table 1: Distribution of participants according to age categories

Age	Frequency	Percent
18-20	6	3.1
21-25	9	4.6
26-30	5	2.6
31-35	10	5.1
36-40	15	7.7
41-45	15	7.7
46-50	20	10.2
Above 50	116	59.2
Total		

Table 2: Distribution of the participants according to the causes of dialysis

Cause	Frequency	Percent
After ophthalmic surgery	1	0.5
After pregnancy	2	1.0
Analgesics	5	2.6
CKD	7	3.6
Congenital	6	3.1
Diabetes Mellitus	13	6.6
Fever	1	0.5
Gout	1	0.5
Hypertension	47	24.0
Hypertension and Diabetes Mellitus	6	3.1
Hypertension and Kidney failure	1	0.5
Kidney atrophy	12	6.1
Kidney failure	49	25.0
Medications	3	1.5
Recurrent infections	1	0.5
SLE	3	1.5
Unknown	34	17.3
UTI	4	2.0
Total	196	100.0

Regarding the type of AVFs it was observed that RCF was seen in 64% of the patients, in which 45 had left RCF and 6 had right RCF. BCF was seen in 73 (37.2%) of the patients in which 51 had left and 22 had right BCFs. Brachio basilic fistula (BBF) was present in 42 (21.4%) of the patients, of which 35 had left and 7 had right BBFs. The prevalence of brachio median antecubital fistulas (BAFs) was 5.6% ($n = 11$) in which 4 were left and 7 were right. The femoral and saphenous vein fistula (FSF) type was present in 6 (3.0%) patients and out of which 1 were left and 9 were right FSFs [Figure 1].

In our study we found that 96.9% had dialysis three time/week, 2.0% had twice and only 1.0% reported having once in a week. The findings of the study show that 19 (9.7%) patients had bleeding from the AVF, whereas 27 (13.8%) patients had venous HTN due to AVF. The aneurysm at the site of AVF was seen in 49 (25%) patients. [Table 3].

The incidence of ischemic neuropathy was present in 58 (29.6%) patients and 6 (3.1%) patients had history of heart failure.

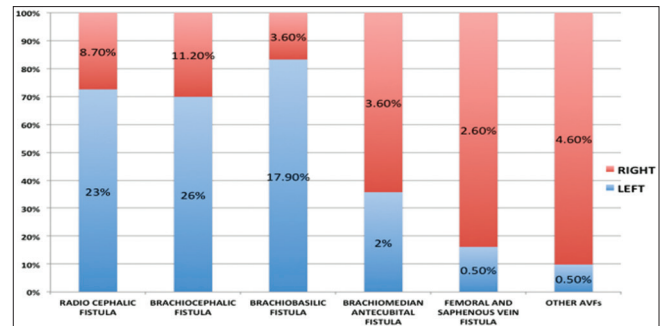


Figure 1: Distribution of AVFs according to type and side

The lymphedema at the site of AVF was present in 3 (1.5%) patients [Table 3]. When the relationship of history of complications with smoking status of patients was seen, it was found that there was no association observed, $P > 0.05$ except with patients who were smokers had history of myocardial infarction than non-smokers, $P < 0.05$ [Table 3].

When the relationship of type of AVFs with age of the patients were assessed, there was no possible association observed expect with femoral and saphenous vein fistula (FSF). Patients with FSFs had comparatively “right type” than “left type,” $P < 0.001$, [Table 4].

Discussion

HD is a temporary treatment for patients who are candidates for kidney transplantation and a permanent treatment for the ESRD patients with no chance of kidney transplantation.^[12] In our study, most of the patients who had AVF were above the age of 40 years and the prevalence increased as the age increased. Complication related to AVF increases as the age increases and the management is usually very difficult.^[13-15]

The most prevalent cause of dialysis in our study was found to be renal failure followed by hypertension. Researchers claim that occurrence of AVF insufficiency is mostly a result of pre-existing morphologic abnormalities due to the underlying disease such as renal failure or other causes. The findings showed that the prevalence of HTN alone was more (40.3%), followed by asthma alone (3.6%). About 30.6% of patients had multiple chronic illness. These findings support the findings of study done by (Codreanu *et al.*, 2012).^[16]

The most common complication seen in these patients was “ischemic neuropathy” (29.6%) followed by “aneurysm at the site of AVF” (25%). In a study done by Cavallaro *et al.*, the most common complications reported were aneurysm followed by thrombosis.^[17] Researches show that male gender was associated with an increased prevalence of HTN, microalbuminuria, and reduced renal function.^[18,19] But, another study done by Nakagawa *et al.* reported that thrombosis with dysfunction of AVF was the most common complication (70.8%), while aneurysm occurred in 6.6% of the patients.^[20] According to the published researches the important complications of fistulae are lymphedema, infection,

Table 3: Distribution of the participants according to the history of complications (No.: 196)

Complication	No (No. (%)	Yes No (%)	Relationship with Smoking (p)	Relationship chronic illness (p)
Bleeding from the AVF	177 (90.3%)	19 (9.7%)	0.311	0.876
Venous HTN	169 (86.2%)	27 (13.8%)	0.657	0.092
Aneurysm at the site of AVF	147 (75%)	49 (25%)	0.747	0.921
Ischemic Neuropathy	138 (70.4%)	58 (29.6%)	0.541	0.645
History of Heart Failure	190 (96.9%)	6 (3.1%)	0.315	0.447
History of lymphedema at the site of AVF	193 (98.5%)	3 (1.5%)	0.416	<0.001*
History of stenosis at the site of AVF	157 (80.1%)	39 (19.9%)	0.359	0.536
History of Myocardial Infarction	190 (96.9%)	6 (3.1%)	0.037*	0.928

Table 4: Relationship between age of the studied patients and the type of AVF

Variable		Type of AVF									
		RCF		BCF		BBF		BAF		FSF	
		L	R	L	R	L	R	L	R	L	R
Age	18-20	2	0	1	0	0	0	0	0	0	0
	21-25	3	0	1	1	1	0	0	0	0	2
	26-30	1	1	0	0	1	0	1	1	1	0
	31-35	4	2	1	0	2	0	1	0	0	0
	36-40	6	1	1	0	4	2	0	0	0	0
	41-45	1	2	4	2	4	1	0	0	0	0
	46-50	4	2	7	3	5	1	0	0	0	1
	Above 50	24	8	36	16	18	3	2	6	0	2
Pearson Chi-square value		12.189		19.047		11.232		20.563		54.496	
P		0.591		0.163		0.668		0.113		<0.001*	

N.B: R=Right; L=Left

aneurysm, stenosis, congestive heart failure, steal syndrome, ischemic neuropathy, and thrombosis.^[21]

The choice of surgical technique for anastomosis has its own characteristics and it is a very important procedure to avoid certain surgical complications. End-to-end anastomosis requires a formidable surgical technique, especially when there is a discrepancy between the lumen of the arteries and veins. This can lead to ischemia of the distal extremities, especially in the elderly and patients with DM. Side-to-side anastomosis is technically easier and can be done if the blood vessels are close to each other. It must be noted that this type of anastomosis may lead to development of venous HTN. Currently, the most acceptable option is end-to-side anastomosis.^[22-24] When considering the complications some of the preoperative factors that should be considered are the outflow vein diameter, arterial diameter and flow rate in the vein and across the anastomosis, all of which could have an effect on the success of fistulas, especially in proximal and distal arm fistulas.^[25]

Infections account about 20% of all AVF complications and most common infections include perivascular cellulitis, which manifests as localized erythema and edema and is usually easily treated. Much more serious is an infection associated with anatomical abnormalities, such as aneurysms, hematomas or abscesses, which require surgical excision and drainage.^[26]

In our study, ischemic neuropathy was seen in 16.1% of the patients and was common in diabetic patients. It is often manifested by weak arms, in the immediate preoperative period, severe pain, and paresthesia.^[27]

Although risk factors are important, risk stratification schemes based on demographic and clinical parameters fail to accurately identify individuals in whom AVF placement is futile. The most important determinant in the success of an AVF is the quality of the available vessels (i.e. hemodynamic factors).^[28] Individualization based upon pre-procedural vascular mapping is critical. As an example, an older black diabetic female with good vessels is a superior AVF candidate compared with a young white nondiabetic male with poor vessels. In a recent study done by Bae *et al.*, it was suggested to undergo autologous AVF as the choice of vascular access in elderly HD (HD) patients.^[29] Some studies revealed that the deaths in patients on HD are very minimal due to access-related problems, and mediation analyses indicated that vascular access complications were not able to adequately explain the association between access type and death.^[30,31] No patient with ESRD should be excluded from consideration for an AVF without vascular mapping and evaluation by an experienced HD access vascular surgeon.

Conclusion

Knowledge about the potential complications of AVFs should contribute to their timely detection and allow measures to be taken that might prevent deleterious consequences that range from loss of vascular access to serious morbidity and may ultimately be fatal. Both the patient and professional should give utmost care for the AVF to reduce the complications. Early diagnosis and management of complications related to AVF is also essential to prevent loss of the vascular access.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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