Predictors of Angio Access Failure in End Stage Renal Disease Patients in Southern Egypt

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ABSTRACT

Background: Hemodialysis (HD) seems to be the most often used Renal Replacement Therapy (RRT) modality worldwide, and it is the primary modality in the majority of instances with extended RRT. The ability to provide our patients with high-quality HD treatment while also increasing their chances of survival is heavily reliant on the functionality of the vascular access (VA). Despite the fact that it is a very necessary component of all clinical practise standards, it is the most expensive individual component of RRT.

Objectives: This study was aimed at comparing between the group with Angio access failure and group without Angio access failure and predicting Angio access failure among end stage renal failure patients in Southern Egypt.

Subjects and Methods: a prospective cohort study among 125 patients with end stage renal failure at Aswan University. The research comprised patients who had NCVA placement [intra-atrial catheter (IAC) and trans-lumbar catheter (TLC)] between January 1, 2020, and December 31, 2020.

Results: The duration of previous RRT was significantly higher among the Angio access failure than the group without Angio access failure. In multivariate analysis using logistic regression, the age, duration of previous RRT, diabetes, IHD (ischemic heart disease), PVD (peripheral vascular disease) and CVD (cardiac vascular disease) were significantly direct predictors of the Angio access failure in the first one year.

Conclusion: In conclusion the failure of Angio access was positively associated with age, previous RRT and other comorbidities.

Keywords: Hemodialysis, Angio access failure, end stage renal disease.

INTRODUCTION

Every year, the number of people being cured for end-stage renal disease (ESRD) increases at a substantially faster rate than the worldwide population. On December 31, 2017, for example 592,779 prevalent individuals in Europe were undergoing renal replacement therapy (RRT). Hemodialysis (HD) was the most common RRT, with 57 percent of patients receiving it. Peritoneal dialysis was utilized by 5 percent of patients, while 37 percent had a functional kidney transplant [1]. Hemodialysis (HD) is now the most prevalent Renal Replacement Therapy (RRT) modality in the globe, and it is the predominant modality in the majority of instances with extended RRT. In certain countries, such as Japan, over 100% of the population has access to HD. Although it is a common medication in nations like the United States, there are concerns regarding its high cost [2].

The ability to provide high-quality HD treatment that allows our patients to live longer is heavily reliant on the vascular access's (VA) ability to operate properly, While it is a required component of all clinical practice standards, it is also the most costly component of RRT. In the United States, keeping a VA might cost up to 30% of the entire cost of an HD programme every year. [3]. The development and maintenance of arteriovenous hemodialysis access (AV access) are two of the most challenging aspects of hemodialysis patient care [4].

There are three forms of traditional vascular access: 1) autologous arteriovenous fistulas (AVF), which are the best option in terms of complications and survival. 2)arterial-venous grafts (AVG; prosthetic VA's made of synthetic material) and 3) a central venous catheter (CVC) [put in a vein with a high calibre (usually the jugular, femoral, or subclavian veins)] [5].

A main prosthetic AV access for hemodialysis has a 1-year problem risk of 33 percent to 99 percent. Various researchers have reported on the viability and problems of AV access. Technique failure is a common consequence of peritoneal dialysis (PD) therapy, and it puts patients and healthcare providers at risk. The first year is known to be a particularly sensitive phase, with studies predicting that slightly under half of patients who have technique failure do so during this time. Although stated rates of early method failure range from 4.9 percent to 20.9 percent depending on the criteria [6].

However, due of the large range of access materials, designs, locations, risk factors, and quality of input and outflow vessels, comparing outcomes is challenging [7]. The National Kidney Foundation's (NKF) offers "Dialysis Outcome Quality Initiative" guidelines for best clinical practices targeted at increasing dialysis outcomes and patient survival. [4].

This study was aimed at comparing between the group with Angio access failure and group without Angio access failure and predicting Angio access failure among end stage renal disease patients in Southern Egypt.

SUBJECTS AND METHODS

This prospective cohort study included a total of 125 patients with end stage renal failure, attending at Aswan University Hospitals.

Patients were admitted for getting maintenance renal replacement therapy (RRT).

All elderly patients aged twenty to eighty years who have been diagnosed with ESRD, hemodialysis, and ES-VAF (> 4 accesses, with stenosis or thrombosis of central veins, as determined by imaging). The research comprised participants who had NCVA placement (IAC or TLC) between January 1, 2020, and December 31, 2020, including those who had obtained RRT in the form of HD or kidney transplantation. At the moment of kidney transplantation, improvement of renal function, and loss to follow-up, patients were censored.

Data collection: each participant was asked to provide relevant socio-demographic information including age, gender, BMI, etiology of end-stage renal disease, length of prior RRT, diabetes, current or past smoking, ischemic heart disease, peripheral vascular disease, and cerebrovascular illness.

The major result looked at the determinants of method failure during the first year, which was divided into four categories: mortality, infectious disease, mechanical failure, and other.

Access preparation:

Vein mapping is a non-invasive method of determining the size of veins and checking for stenosis or blockage in the central veins. With blood pressure measures, arterial wave shapes, and velocities, assess the arteries for size and probable arterial inflow disease. Anatomic and physiologic measures that are preferred: A transverse arterial diameter of 2 mm with minimum calcification is required. A 2.5 mm venous segment with a length of > 15 cm is required. Brachial art is a type of brachial art. The difference between the Bl. pr. and the difference between the Bl. pr. and the difference between the Bl. pr. Palmer arch patent

When there is edema in the extremities, chest wall or arm collateral veins, or a history of several previous catheters on the side of the desired access, a venogram is required prior to the development of an AV access. Placement of an AICD or a pacemaker.

Evaluation after surgery: Autogenous fistula development takes 12-16 weeks on average. The 6s rule is used to measure autogenous fistula maturation: flow of 600 cc/min, diameter above 6 mm, depth 6 mm, and cannulation length of 6 inches. If rapid maturation or aneurysmal dilatation occurs, excessive venous pressure is likely due to central vein stenosis. Grafts are available in two to three weeks.

Ethical approval

The Ethics Committee of the Faculty of Medicine, Aswan University approved the study protocol, and all patients gave a written informed consent for participation in this study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

The data was digitized and statistically analyzed using the SPSS (Statistical Package for Social Science) version 26 application. The Shapiro Walk test was used to determine whether the data had a normal distribution. Frequencies and relative percentages were used to express qualitative information. As shown, the Chi square test ($\chi2$) was employed to quantify the difference between qualitative variables. The mean and standard deviation were used to represent quantitative data.

Student t test was used to calculate difference between quantitative variables in two groups for parametric and non-parametric variables. Multiple logistic regressions to predict Angio access failure. All statistical comparisons were with significance Level of P-value < 0.05 indicates significant while, P≥ 0.05 indicates non-significant change.

RESULTS

A total sample of 125 patients with end stage renal diseases undergoing Angio access after 1 year follow up, there were 25 patients had Angio access failure while 100 hadn't. When investigated sociodemographic data, the mean age was 63.4± 20.5 among those with Angio access failure and was 50.1± 22.7 among none-failure group. There was statistically significant difference regarding age groups as there were 52% and 24% aged higher than 60 years among group with Angio access failure and group without respectively.

There were 52% females and 48% males among group with Angio access failure while there were 55% males and 45% females among group without Angio access failure. There was no statistically significant difference between both groups regarding gender and mean body mass index **(Table 1).**

Table 1: Sociodemographic data of the participants

Variable		Angio access failure group (n= 25)	No failure group (n= 100)	P value
Age (years)	Mean± SD	63.4± 20.5	50.1± 22.7	**0.020***
	<40 n (%)	3 (12)	45 (45)	
	40-60 n (%)	5 (20)	31 (31)	**0.011***
	>60 n (%)	13 (52)	24 (24)	
Gender	Male n (%)	12 (48)	55 (55)	
	Female n (%)	13 (52)	45 (45)	0.501
BMI (kg/m^2)	Mean± SD	28.6± 7.3	26.9± 6.2	0.600

Student t test; Chi square test; *p is significant at <0.05

When comparing causes of ESRD among both groups, there were 36% and 28% had ESRD due to cystic cause and other causes respectively among group with Angio access failure. While there were 24% and 34% due to diabetes and other causes respectively among group without Angio access failure. There was no important change between both groups regarding causes of ESRD. The duration of previous RRT was significantly higher among the Angio access failure than the group without Angio access failure. As there were 28% among Angio access failure group and 20% among group without Angio access failure had previous RRT duration more than 3 months **(Table 2).**

Table 2: Comparison between the two groups regarding causes of ESRF and duration of RRT

Variable		Angio access failure group n (%)	No failure group n (%)	P value
Causes of ESRD	Glomerulonephritis	5 (20)	20 (20)	
	Diabetes	4 (16)	24 (24)	
	Cystic	9 (36)	22 (22)	0.709
	Other	7 (28)	34 (34)	
Duration of RRT	Nil	10 (40)	66 (66)	
	≤ 3 months	8 (32)	14 (14)	**0.008***
	> 3 months	7 (28)	20 (20)	

Chi square test; *p is significant at <0.05

When we examined comorbidities, there were 60% and 40% had diabetes among group with Angio access failure and group without. There was statistically significant difference between both group regarding diabetes. There was no statistically significant difference between both groups regarding cigarette smoking. The ischemic heart disease was significantly higher among group with Angio access failure than without. The peripheral vascular disease was significantly higher among group with Angio access failure than group without Angio access failure. The cerebrovascular disease was significantly higher among group with Angio access failure than group without Angio access failure **(Table 3).**

Table 3: Comparison between the two groups regarding comorbidities

Variable		Angio access failure group n= 25	No failure group n= 100	P value
diabetes	Yes	15 (60)	40 (40)	
	No	10 (40)	60 (60)	**0.005***
cigarette smoking	No	7 (28)	29 (29)	
	Former	5 (20)	21 (21)	0.600
	Current	13 (52)	50 (50)	
ischemic heart disease	Yes	9 (36)	20 (20)	
	No	16 (64)	80 (80)	**0.041***
peripheral vascular disease	Yes	7 (28)	13 (13)	
	No	18 (72)	87 (87)	**0.022***
cerebrovascular disease	Yes	6 (24)	10 (10)	
	No	19 (76)	90 (90)	**0.008***

Chi square test; *p is significant at <0.05

In multivariate analysis using logistic regression, the age, duration of previous RRT, diabetes, IHD, PVD and CVD were significantly direct predictors of the Angio access failure in the first one year **(Table 4).**

Table 4: Predictors of Angio access failure among the participants.

Variable	CI	P value
Age	0.94- 1.07	**<0.001***
Duration of RRT	0.51-1.09	**<0.001***
Diabetes	1.01-1.65	**0.003***
IHD	1.05- 1.44	**0.020***
PVD	1.03- 1.51	**0.011***
CVD	1.04- 1.73	**<0.001***

Logistic Regression: *p is significant at <0.05

DISCUSSION

Hemodialysis is used to treat around 70 % of persons with end-stage renal failure (nearly 3 million people worldwide). Despite its effectiveness in prolonging life, hemodialysis is linked with poor results (one in every six persons dies each year) and is exceedingly expensive [2].

Hemodialysis patients make up less than 1% of Medicare and Medicaid recipients, yet they account for 6% – 7% of health-care cost. Establishing and maintaining a vascular access (a fistula, graft, or tunneled catheter) that permits access to the bloodstream for the delivery of hemodialysis treatment accounts for a significant portion of this expense [8].

Hemodialysis access complications (such as clotting or infection) are widespread, and they often result in access-related operations or medical interventions, which are a major cause of morbidity and death in this patient group. [9].

The treatment of ESRD patients necessitates a significant investment of public and private monies from around the country. The best accessible vascular access (VA) for HD is an autogenous arteriovenous fistula (AVF). When compared to the expense of arteriovenous grafts (AVGs) or central venous catheters (CVCs), one of the benefits of AVF is the reduced total cost [10].

Vascular access for hemodialysis has progressed significantly in recent years. The classic Scribner shunt has been replaced as a temporary access device by double lumen catheters inserted into broad bore veins, minimizing the problems and morbidity associated with it [11].

New additions to the vascular access arsenal include cuffed tunnelled internal jugular catheters and synthetic arteriovenous (AV) grafts typically composed of polytetrafluoroethylene, but the AV fistula, established in 1966, remains the lifeline for chronic hemodialysis patients [12].

Synthetic AV grafts, on the other hand, are useful in the elderly and diabetic individuals. Synthetic grafts have the extra benefit of a quick maturation time and various possible access locations. Access failure is caused by venous stenosis and thrombotic events in 80% of cases, whereas infections or other problems are present in 20% of cases.[6].

This study was aimed at comparing between the group with Angio access failure and group without Angio access failure and predicting Angio access failure among end stage renal failure patients in Southern Egypt.

In the current study, A total sample of 125 patients with end stage renal diseases undergoing Angio access after 1 year follow up there were 25 patients had technical failure while 100 hadn't. When investigated socio-demographic data, the mean age was 63.4± 20.5 years among those with technical failure and was 50.1± 22.7 years among none-failure group. There was statistically significant difference regarding age groups as there were 52% and 24% aged higher than 60 years among group with technical failure and group without respectively.

Technique failure within the first year of PD therapy was linked to individuals above the age of 70 in a large cohort of patients from Australia and New Zealand [13].

In the current study, when comparing causes of ESRD among both groups, there were 16% and 24% had ESRD due to diabetes among group with technical failure and group without technical failure respectively. There was no statistically significant difference between both groups regarding causes of ESRD.

Similarly, Vera and his colleagues found that Diabetes mellitus (DM) in our series was 10% as the etiology of ESRD [7].

In our study, the duration of previous RRT was significantly higher among the technical failure than the group without technical failure. As there were 28% among technical failure group and 20% among group without technical failure had previous RRT duration more than 3 months.

Additionally, See and his colleagues conducted a study aimed at examining the cause of technique failure within the first year, categorized as death, infectious, mechanical, or other. They found that there was significantly association between prior RRT and technical failure [13].

In the current study, the rate of failure in our study was 20%. A study conducted by Voorzaat and his colleagues and the rate of failure in their study (24%) was similar to ours [14].

In multivariate analysis using logistic regression in our results, the age, duration of previous RRT, diabetes, IHD, PVD and CVD were significantly direct predictors of the Angio access failure in the first one year.

Similarly, Woodside et al., discovered that a variety of comorbid disorders were linked to a longer time to AVF usage and maturation, as well as failure. We discovered that older age, the requirement for assistance, and institutionalization were all linked to AVF maturation delays and increased failure rates [15].

CONCLUSION

In conclusion the failure of Angio access was positively associated with age, previous RRT and other comorbidities.

Declarations:
Consent for Publication: I confirm that all authors accept the manuscript for submission.
Availability of data and material: Available
Competing interests: none
Funding: No fund.
Conflicts of Interest: The authors declare no conflicts of interest regarding the publication of this paper.

REFERENCES
1. **Robbin M, Greene T, Allon M** *et al.* **(2018):** Prediction of arteriovenous fistula clinical maturation from postoperative ultrasound measurements: findings from the hemodialysis fistula maturation study. J Am Soc Nephrol., 29(11):2735–44 .
2. **Thamer M, Lee T, Wasse H** *et al.* **(2018):** Medicare costs associated with arteriovenous fistulas among US hemodialysis patients. Am J Kidney Dis.,72(1):10–8 .
3. **Shiu Y, Rotmans J, Geelhoed W** *et al.* **(2019):** Arteriovenous conduits for hemodialysis: how to better modulate the pathophysiological vascular response to optimize vascular access durability. Am J Physiol Physiol., 316(5):F794–806 .
4. **Magar D, Shrestha K, Chapagain D** *et al.* **(2020):** Comparative Study of Autologous Radiocephalic and Brachiocephalic Arteriovenous Fistula in Patients with End Stage Renal Disease. J Nepalgunj Med Coll., 18(1):78–81 .
5. **Pillai A, Kumar G, Kalva S (2021):** Peripheral Arterial Disease in Hemodialysis Access. In: Dialysis Access Management. Springer,pp: 165–77 .
6. **Nishida H, Fukuhara H, Nawano T** *et al.* **(2021):** Adjuvant heparinization before manipulation of artery reduces early failure in primary arteriovenous fistula for end-stage renal disease patients. Clin Exp Nephrol., 1–8 .
7. **Vera A, Lopez M, Martinez C** *et al.* **(2021):** Patency of trans-lumbar and intra-atrial catheters in patients with end stage renal disease and end stage vascular access failure. Trends Med., 21(4):1–7 .
8. **Hull J, Jennings W, Cooper R** *et al.* **(2018):** The pivotal multicenter trial of ultrasound-guided percutaneous arteriovenous fistula creation for hemodialysis access. J Vasc Interv Radiol., 29(2):149–58 .
9. **Berland T, Clement J, Griffin J** *et al.* **(2019):** Endovascular creation of arteriovenous fistulae for hemodialysis access with a 4 Fr device: clinical experience from the EASE study. Ann Vasc Surg., 60:182–92 .
10. **Irani F, Teo T, Tay K** *et al.* **(2018):** Hemodialysis arteriovenous fistula and graft stenoses: randomized trial comparing drug-eluting balloon angioplasty with conventional angioplasty. Radiology, 289(1):238–47 .
11. **Ravani P, Quinn R, Oliver M** *et al.* **(2017):** Examining the association between hemodialysis access type and mortality: the role of access complications. Clin J Am Soc Nephrol., 12(6):955–64 .
12. **Woodside K, Repeck K, Mukhopadhyay P** *et al.* **(2021):** Arteriovenous vascular access–related procedural burden among incident hemodialysis patients in the United States. Am J Kidney Dis., 18(4):44–52 .
13. **See E, Johnson D, Hawley C** *et al.* **(2018):** Risk predictors and causes of technique failure within the first year of peritoneal dialysis: an Australia and New Zealand Dialysis and Transplant Registry (ANZDATA) study. Am J Kidney Dis., 72(2):188–97 .
14. **Voorzaat B, van der Bogt K, Janmaat C** *et al.* **(2018):** Arteriovenous fistula maturation failure in a large cohort of hemodialysis patients in the Netherlands. World J Surg., 42(6):1895–903 .
15. **Woodside K, Bell S, Mukhopadhyay P** *et al.* **(2018):** Arteriovenous fistula maturation in prevalent hemodialysis patients in the United States: a national study. Am J Kidney Dis., 71(6):793–801 .