Alexandria Journal of Medicine

ISSN: 2090-5068 (Print) 2090-5076 (Online) Journal homepage: https://www.tandfonline.com/loi/tajm20

Vascular access complications and risk factors in hemodialysis patients: A single center study

Tarek A. Ghonemy, Salama E. Farag, Sameh A. Soliman, Essam M. Amin & Amal A. Zidan

To cite this article: Tarek A. Ghonemy, Salama E. Farag, Sameh A. Soliman, Essam M. Amin & Amal A. Zidan (2016) Vascular access complications and risk factors in hemodialysis patients: A single center study, Alexandria Journal of Medicine, 52:1, 67-71, DOI: 10.1016/j.ajme.2015.04.002

To link to this article: https://doi.org/10.1016/j.ajme.2015.04.002

Alexandria Journal of Medicine (2016) **52**, 67–71

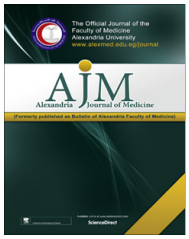
HOSTED BY

ELSEVIER

Alexandria University Faculty of Medicine

Alexandria Journal of Medicine

http://www.elsevier.com/locate/ajme



Vascular access complications and risk factors in hemodialysis patients: A single center study

Tarek A. Ghonemy [a,*], **Salama E. Farag** [a], **Sameh A. Soliman** [a], **Essam M. Amin** [a], **Amal A. Zidan** [b]

[a] *Internal Medicine Department, Nephrology Unit, Zagazig University Hospital, Egypt*
[b] *Clinical Pathology Department, Zagazig University Hospital, Egypt*

Received 24 December 2014; accepted 20 April 2015
Available online 18 August 2015

KEYWORDS

Vascular access;
Hemodialysis;
Complications

Abstract *Background:* Morbidity related to vascular access is the leading cause of hospitalization for chronic hemodialysis patients and is associated with high cost. Since data on vascular access complications are scarce, this study was designed to focus on vascular access complications in hemodialysis patients.

Methods: 119 patients with End Stage Renal Disease (ESRD) on regular hemodialysis were recruited for the study, They were subjected to the following Laboratory blood tests: Kidney function tests, CBC, KT/V, serum albumin, fasting blood sugar, swab culture and sensitivity from the skin over the vascular access and blood culture and sensitivity from both central and peripheral samples, In addition, radiological Doppler ultrasound was done for all patients to evaluate the vascular access.

Results: 27 out of 119 patients (22%) have positive blood culture, 64 (53.7%) patients have positive swab culture, 68 (57%) patients have stenosis, 25 patients (21%) have athermanous plaques and 44 (36.9%) patients have aneurysmal dilatation. There was a significant low Kt/V in patients with stenosis and aneurysmal dilatation ($p < 0.001$). Low Kt/V, low serum albumin level and low BMI were significant in patients with central blood infection ($p < 0.008$, < 0.008 and < 0.001 respectively). There was significant increase in the risk of infection in male patients, patients with low BMI, increased BUN and increased duration of HD session ($p < 0.046$, < 0.008, < 0.002 and < 0.009 respectively). Stenosis was the most common risk factor for vascular failure as it

* Corresponding author at: Medicine Department, Nephrology Unit, Zagazig University Hospital, PO Box 44519, Al Sharqia Governorate, Egypt.
E-mail address: tarekghonemy@hotmail.com (T.A. Ghonemy).

Peer review under responsibility of Alexandria University Faculty of Medicine.

http://dx.doi.org/10.1016/j.ajme.2015.04.002

occurred in (29%) of patients. Diabetes was the second common risk factor for vascular failure as it occurred in (17%) of patients.

Conclusion: Stenosis and infection are the most common complications of the vascular access. DM is an important risk factor for the incidence of infection. Other risk factors for dialysis CRBSI include older age, low serum albumin, high BUN and decreasing the duration of dialysis.

1. Introduction

Hemodialysis has become an increasingly safe and well-tolerated therapy for patients with end-stage renal disease (ESRD). Nevertheless, life expectancy of dialysis patients remains significantly shorter than that of the general population with similar demographics.[1] Arterio-venous fistula (AVF) is the preferred access for patients who require regular Hemodialysis (HD) and the preferred site is the wrist, preferably in the non-dependant arm.[2] A standard Arteriovenous fistula (AVF) is created from anastomosis of cephalic vein with radial artery at the wrist. Tunneled dialysis catheters are used for temporary vascular access in patients awaiting placement or maturation of a permanent vascular access (AVF or AV graft). They are also required for long-term access in patients who have exhausted all options for placement of a permanent access in all four extremities. They are usually placed in a central vein in the chest, most commonly in the internal jugular vein, and less commonly in the subclavian vein. However, they can be used also in femoral veins whenever indicated and due to their proximity to the groin; one would anticipate they would be more prone to problems with low dialysis blood flows, loss of patency, and catheter-related bacteremia.[4] Vascular access complications are of great burden in the chronic hemodialysis population. Morbidity related to vascular access is the leading cause of frequent hospitalization among chronic hemodialysis patients and is associated with huge financial problem. The Clinical Practice Guidelines for Vascular Access of the National Kidney Foundation's Dialysis Outcomes Quality Initiative (KDOQI) recommend use of arteriovenous (AV) accesses (native fistulae or synthetic grafts) for hemodialysis over using the venous catheter as they provide higher blood flow rates than do venous catheters and are associated with lower rates of infection, thrombosis, septicemia, and central venous stenosis which are common complications of the venous catheters. KDOQI Guidelines further recommend fistulae over grafts, as most studies have found fistulae to have fewer complications.[5] Other complications of AVF include thrombosis, infection, bleeding, increased venous pressure, arterial insufficiency, aneurysm, carpal tunnel syndrome, distal ischemia and even heart failure.[6] Since data on vascular access complications are scarce in Egypt, this study was designed to focus on vascular access complications and their common risk factors in Egyptian hemodialysis patients.

2. Subjects and methods

This cross sectional study has been carried out in the nephrology unit, and clinical biochemistry departments, Zagazig University Hospitals, Egypt in the period between May 2012 and April 2014. One hundred and nineteen patients with ESRD on regular HD were recruited for the study.

They were receiving bicarbonate base dialysis using a high flux polysulphonesynthetic dialyzer with an average blood flow of 300–350 mL/min, 3 times/week with target 4 h duration for each dialysis session, 79 out of them were males and 40 were females. Their ages ranged from 25 to 76 years with mean of 46.47.78 ± 09.85 years. The duration of haemodialysis ranged from 1 to 12 years with mean of 7.84 ± 3.54 years. 46 (38.7%) patients were diabetics and 77 (64.7%) patients were hypertensive.

2.1. Vascular accesses

One hundred and seven patients were dialyzed through AVF, ten patients were dialyzed through permanent tunneled catheters and two patients were dialyzed through AV graft. All patients of the unit on HD were candidates for the study except patients with obvious infection, malignancy, recently created AVF and patients with temporary non-tunneled catheters were excluded from the study. All subjects of the study were subjected to the following: thorough full history taking and clinical examination, laboratory blood tests which included: kidney function tests, Complete Blood Count (CBC), single pool Kt/V, serum albumin by colorimetric method, fasting blood sugar, swab culture and sensitivity from the skin over the vascular access and blood culture and sensitivity from both central and peripheral samples. Blood samples for blood culture were taken before dialysis session. Under complete aseptic condition, 10 mL of blood was taken through the catheter and a peripheral vein puncture and injected into two "blood bottles" with specific media for aerobic and anaerobic organisms and fungal infection. Also all patients underwent radiological Doppler ultrasound examination to evaluate the vascular access by high-resolution real-time B mode ultrasonography with a 7.5-MHz linear transducer (SSH 140A Toshiba, Japan). The examination involved 2D and Doppler vascular access examination, with the former allowing evaluation and detection of any abnormalities in the vascular access such as stenosis, atheromatous plaque, aneurysm, pattern of blood flow and distal ischemia.

3. Statistical methods

Statistical analyses were performed with Statistical Package for Social Sciences version 17.0 for Windows (SPSS Inc., Chicago, IL). Continuous variables are presented as mean ± SD or median and range. Chi-square test was used for qualitative data (frequency and proportion), student *t*-test was used to

compare 2 groups. One way ANOVA test was used to compare more than 2 groups. Post Hoc test LSD (least significance difference) was used for intra group differences. For non-parametric data (median and range), Kruskal–Wallis test was used to compare more than 2 groups and Mann–Whitney test was used to compare between 2 groups. Risk factors for the incident of infection were analyzed by logistic regression analysis. *P* is significant if <0.05 at confidence interval 95%.

4. Results

Regarding the vascular complications in the studied subjects, 68 (57%) patients had stenosis of the access, 25 (21%) had athermanous plaques and 44 (36.9%) patients had aneurysm.

There was significant low Kt/V in patients with stenosis and aneurysmal dilatation in comparison with patients without theses complications ($p < 0.001$). On other hand , no significant differences were reported between patients with and those without vascular complications (stenosis, aneurysmal dilatation and atheromatous plaques) regarding age, duration of HD session, random blood sugar, serum albumin level and BMI Table 1.

Regarding prevalence of infection in the studied patients, 27 (22.7 %) had positive blood culture with 17 patients having *Staphylococcus aureus* (*S. aureus*) infection, 6 patients having pseudomonas infection and 4 patients having *Klebsiella pneumoniae* infection. There was no fungus infection Table 2.

Local Skin infection over the access, according to the swab culture and sensitivity was reported for bacteria in 64 (53.7%) patients with 57 (47.8%) having infection by *S. aureus*, 5 (4.2%) having infection with pseudomonas and 2 (1.6%) patients with *K. pneumoniae* infection. Again no fungus infection was reported Table 3.

Significant low Kt/V, low serum albumin level and low BMI were observed in patients with systemic infection in comparison with patients without infection ($p < 0.008$, <0.008 and <0.001 respectively) Table 2.

For patients with local infection, there was significant increase in the duration of HD and random blood sugar, a decrease in serum albumin level and in BMI in comparison with patients without infection ($p < 0.001$, <0.036, <0.036 and <0.001 respectively) (Table 2).

When logistic regression analysis was done, we found significant increase in the risk of infection in male patients, patients with low BMI, increased BUN and increased duration of HD session ($p < 046$, $<.008$, <0.002 and $<.009$ respectively) (Table 3).

In comparing diabetic and non-diabetic patients regarding the incident of vascular abnormalities and incident of infection, we found that the atheromatous plaques were significantly increased in diabetic patients in comparison with non-diabetics ($p < 0.008$). The incident of local skin infection with positive swab culture was statistically significantly increased in diabetic patients in comparison with non-diabetics ($p < 0.001$) (Table 4).

The total incidents of vascular complication was statistically higher in hypertensive group in comparison with non-hypertensive group ($p < 0.009$) (Table 5).

Stenosis was the most common risk factor for vascular failure as it occurred in (29%) of our patients. DM was the second common risk factor for vascular failure as it occurred in (17%) of our patients. Hypertension (HTN) and Systemic infection were the third common risk factor for vascular failure as they

Table 1 Comparison between different vascular complications regarding different clinical and laboratory parameters.

	Age (years) Mean ± SD	Dialysis time (h) Mean ± SD	Kt/V Mean ± SD	Random blood sugar (mg/dl) Mean ± SD	Serum albumin (g/d) Mean ± SD	BMI Mean ± SD
Stenosis	46.30 ± 11.09	4.76 ± 3.12	1.52 ± 0.14	108.8 ± 39.1	3.78 ± 0.43	22.42 ± 3.11
No stenosis	47.55 ± 9.16	5.14 ± 3.35	1.42 ± .16	120.1 ± 55.9	3.80 ± 0.49	23.41 ± 3.32
P value	0.513	0.525	0.001	0.190	0.814	0.097
Aneurysm	47.59 ± 9.97	5.24 ± 3.46	1.51 ± 0.15	118.2 ± 54.7	3.76 ± 0.49	23.08 ± 3.41
No aneurysm	46.0 ± 10.11	4.50 ± 2.81	1.411.51 ± 0.15	109 ± 35.2	3.85 ± 0.41	22.82 ± 3.01
P value	0.408	0.207	0.001	0.600	0.286	0.665
Atheromatous plaque	46.91 ± 9.5	5.0 ± 3.30	1.48 ± 0.15	114.5 ± 49.01	3.78 ± 0.46	23.14 ± 3.20
No Atheromatous plaque	47.54 ± 12.2	4.85 ± 3.05	1.44 ± 0.20	119.29 ± 52.09	3.85 ± 0.48	22.23 ± 3.52
P value	0.814	0.832	0.355	0.685	0.521	0.245

Table 2 Comparison between incidence of infection (local and systemic) and different clinical and laboratory parameters.

	Age (years) Mean ± SD	Dialysis time (h) Mean ± SD	Kt/V Mean ± SD	Random blood sugar (mg/dl) Mean ± SD	Serum albumin (g/d) Mean ± SD	BMI Mean ± SD
+ve blood culture	47.07 ± 13.3	4.53 ± 3.20	1.39 ± 0.18	111.50 ± 47.09	3.55 ± 0.51	20.93 ± 3.13
−ve blood culture	47.0 ± 9.10	5.09 ± 3.21	1.54 ± .41	118.9 ± 51.67	3.86 ± 0.43	23.53 ± 3.13
P value	0.980	0.441	0.008	0.502	0.008	0.001
+ve swab culture	46.02 ± 9.88	4.02 ± 2.80	1.50 ± 0.15	127.4 ± 57.9	3.90 ± 0.41	24.10 ± 3.09
−ve swab culture	48.46 ± 9.36	3.26 ± 3.86	1.54 ± 0.54	108.07 ± 40.89	3.73 ± 0.46	22.0 ± 3.13
P value	0.169	0.001	0.597	0.036	0.036	0.001

Table 3 Comparison between incidence of infection and different risk factors.

	B	S.E.	Wald	Sig.
BUN	.038	.012	10.007	.002
Sex	1.122	.563	3.966	.046
BMI	−.238	.089	7.129	.008
Duration of dialysis (h)	.234	.090	6.755	.009

Table 4 Vascular complications in diabetic and non-diabetic patients.

	Non diabetic patients (n = 73)		Diabetic patients (n = (46)		χ^2	*P*
	No	%	No	%		
Atheromatous plaque						
Present	10	11.6	15	31.8	7.009	0.008
Absent	63	88.4	31	68.2		
Culture swab of the vascular access						
Positive	29	39.4	33	72.7	12.065	0.001
Negative	44	60.6	13	27.3		

Table 5 Vascular complications in hypertensive and non-hypertensive patients.

	HTN (n = 77)		No HTN (n = 42)		χ^2	*P*
	No	%	No	%		
Present	38	49.4	9	21.4	6.750	0.009
Absent	39	50.6	33	78.6		

occurred in (14%) of our patients. The lowest complications were aneurysmal dilation in 13.6% of the patients, atheromatous plaques in 8% of the patients and local exit site infection in 3% of the patients.

5. Discussion

Long-term patency of vascular access has prolonged survival of thousands of patients with ESRD on maintenance HD.[7] AVF is the preferred access for patients who require regular HD and the preferred site is the wrist, preferably in the non-dependent arm.[2]

Complications of AVF include thrombosis, infection, bleeding, increased venous pressure, arterial insufficiency, aneurysm, carpal tunnel syndrome, distal ischemia and even heart failure.[6] In the current study, stenosis of the vascular access was the most common complication as it occurred in about 53% of the patients. Infection of the vascular access was the second common complication as it occurred in more than 50% of the patients. The incidence of Systemic infection occurred in 22% of the patients. Stenosis may have occurred partly due to excessive in-growth of fibrous tissue through multiple puncture holes, and partly due to repeated attacks of hypotension during and after the hemodialysis. The result of our study does not go in harmony with the study done by Derakhshanfar and his colleagues,[8] who reported that the most frequently encountered complication in the vascular access was aneurysm (51%), followed by venous hypertension (16.7%), infection (4.4%), thrombosis (3.3%), and arterial steal syndrome (1.1%).

In the current study, *Staphylococcus* infection was the most common type of infections, this goes in agreement with Ratnaja and Susan [9] who reported that the prevalence of *S. aureus* in patients on hemodialysis is 35–62%. In the study of Astor and his coworkers [5], the prevalence of *Staphylococcus aureus* (*S. aureus*) nasal carriage in patients on hemodialysis is 35–62%, a factor that might predispose these patients to *S. aureus*. Jean et al. [10] found that central venous catheter-related bloodstream infection (CRBSI) with S. aureus occurred most often in patients who had nasal colonization; in more than 50% of the infected patients, the same strain of *S. aureus* was detected in nose (or skin) and catheter.

Kt/V decreased significantly in our patients with stenosis of the vascular access; this was in harmony with the study of Campos et al. [11] who reported that stenosis is considered the major cause of dysfunction of arteriovenous fistula that leads to decreasing Kt/V and decreasing the efficacy of hemodialysis. Kt/V decreased significantly in patients with stenosis of the vascular access which may be due to the decrease in the blood flow rate in AVF and recirculation of blood. Recirculation occurs when dialyzed blood returning through the venous needle re-enters the extracorporeal circuit through the arterial needle, rather than returning to the systemic circulation that leads to decrease in urea removal and decrease Kt/V.[15]

Kt/V decreased significantly in patients with aneurysm of the vascular access; which may also be due to recirculation of the blood at the AVF. It is not going with the results of Yu et al. [12] who reported that there are no significant differences in Kt/V between the patients with aneurysm of the vascular access and the patients without aneurysm.

The incidence of atheromatous plaque of the vascular access was high in our patients with DM, this was in agreement with Danese et al. [13] who reported that there is a significant relationship between diabetes and the presence of non-ulcerative plaques.

A significant relationship between Diabetes Mellitus (DM) and positive culture swap of the vascular access was reported in our patients. Infection of the vascular access is increased in patients with DM which goes hand in hand with the study of Ratnaja and Susan [9] who reported that DM is an important risk factor for the incidence of infection. He reported also many risk factors for CRBSI such as older age, higher total intravenous iron dose, increased recombinant human erythropoietin dose, lower hemoglobin level, lower serum albumin level, diabetes mellitus, peripheral atherosclerosis, and recent hospitalization or surgery.

Stenosis was the most common risk factor for vascular failure, as it occurred in (29%) of our patients with stenosis. DM was the second common risk factor as vascular failure occurred in (17%) of the patients with DM. Hypertension and Systemic infection were the third common risk factor as they occurred in (14%) of patients with HTN. This was in agreement to Mauricio et al. [14] who reported the stenosis to be the most common risk factor for vascular failure (51% of patients with stenosis) followed by diabetes mellitus as the second common risk factor for vascular failure (occurred in (14%) of their diabetic patients. Hypertension was the third

common risk factor for vascular failure (13%) of their patients with HTN.

6. Conclusion

Stenosis and infection are the most common complications of the vascular access. Staphylococcus infection is the commonest type of infection. Risk factors for dialysis CRBSI include Diabetes, older age, low serum albumin, high BUN and decreasing the duration of dialysis session.

Limitations

It is a cross sectional study on a small numbers of patients and in a single center and of course, it will be of better value if it was done in a multicenter design on a larger number of patients.

Conflict of interest statement

None.

Disclosure of grants or other funding

None.

References

1. Pozzoni P, Del Vecchio L, Pontoriero G, et al. Long-term outcome in hemodialysis: morbidity and mortality. *J Nephrol* 2004;**17**:S87–95.
2. Massary SG, Glassock RJ. *Massray & Glasswork's textbook of nephrology*. 4th ed. Philadelphia: Lippincott Williams; 2001.
4. Maya Ivan D, Allon Michael. Outcomes of tunneled femoral hemodialysis catheters: Comparison with internal jugular vein catheters. *Kidney Int* 2005;**68**:2886–9.
5. Astor BC, Eustace Joseph A, Powe Neil R, et al. Type of vascular access and survival among incident hemodialysis patients: the choices for healthy outcomes in caring for ESRD (CHOICE) study. *J Am Soc Nephrol* 2005;**l16**:1449–55.
6. Ikizler TA, Himmerlfarb J. Trials and tradeoffs in haemodialysis vascular access monitoring. *Nephrol Dial Transplant* 2006;**21**:3362.
7. Braunwald E, Fauci A, Ajay KS, et al. *Harrison's principles of internal medicine*. 15th ed. Philadelphia: McGraw-Hill Publishing Division; 2005, p. 731–40.
8. Derakhshanfar A, Gholyaf M, Niayesh A, et al. Assessment of frequency of complications of arteriovenous fistula in patients on dialysis: a two-year single center study from Iran. *Saudi J Kidney Dis Transplant* 2009;**20**:872–5.
9. Ratnaja K, Susan H. Central venous catheter-related bacteremia in chronic hemodialysis patients: epidemiology and evidence-based management. *Nat Rev Nephrol* 2007;**3**:256–66.
10. Jean G, Charra B, Chazot C, et al. Risk factor analysis for longterm tunneled dialysis catheter-related bacteremias. *Nephron* 2002;**91**:399–405.
11. Campos RP, Do Nascimento MM, Chula DC, et al. Stenosis in hemodialysis arteriovenous fistula: evaluation and treatment. *Hemodial Int* 2006;**10**(2):152–61.
12. Yu Q, Yu H, Chen S, Wang L, et al. Distribution and complications of native arteriovenous fistulas in maintenance hemodialysis patients: a single-center study. *J Nephrol* 2011;**24**(5):597–603.
13. Danese C, Vestri AR, D'Alfonso V, et al. Do hypertension and diabetes mellitus influence the site of atherosclerotic plaques? *Clin Ter* 2006;**157**(1):9–13.
14. Mauricio MC, Serdar Yilmaz, Anastasio Salazar-Bañuelos, et al. Risk factors associated with patency loss of hemodialysis vascular access within 6 months *CJASN* 2010;**5**:1787–92.
15. Besarab A, Sherman R. The relationship of recirculation to access blood flow. *Am J Kidney Dis* 1997;**29**(2):223–9.

Further reading

3. Kinnaert P, Moris C. Arterivenous fistula at the elbow for maintenance hemodialysis. In: Kootstra G, Jorning PJ, editors. *Access surgery*. Lancaster, Boston, The Hague: MTP Press; 1983. p. 25–293.