ORIGINAL ARTICLE

Assessment of Arteriovenous Graft Survival and Effective Factors in Hemodialysis Patients in Iran

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ABSTRACT

Background: Patients under hemodialysis owe their life to chronic and acute dialysis. An acute dialysis can be done with embedding catheter in a central vein, but in chronic hemodialysis, fistula or arteriovenous graft (AVG) is needed. There are some agents involved with efficacy and complications of graft such as age, peripheral vascular disease, and the onset and length of dialysis. The purpose of this study was to determine the survival rate of AVG and its numerous complications to avoid complications with early detection.

Materials and Methods: In this study, 299 patients from September 2012 to September 2015 under AVG embedded in the operating room in Imam Khomeini Hospital were studied. The duration of the follow-up was 1 year at least for each patient, and the duration of the study was 36 months. To describe the qualitative and quantitative variables, frequency distribution, mean, and standard deviation were reported. Cox regression was used to investigate the relationship between variables and survival time.

Results: The study is conducted with 299 patients under hemodialysis with AVG from September 2012 to September 2014. The mean age was 62.87 ± 13. A total of 127 patients were male and 172 female. The most frequent of AVG was done in left brachial-axillary 226 cases (75.6%). The results of 1 year survival time were 43.5%. In our study, the effect of age, number of previous catheterization, diabetes, and glomerulonephritis on survival rate was significant.

Conclusion: Some conditions can be helpful to reduce the complications of graft and increase the survival rate such as training of staff, training of patients about the regular visit after AVG embedding, the use of new graft with less arterial diameter, early treatment of complications of AVG, and technical principles of vascular anastomosis.

Key words: Arteriovenous fistula, Arteriovenous graft, Graft survival, Hemodialysis

INTRODUCTION

Nowadays, despite the prodigious advances of medicine, chronic renal failure is one of the suffering diseases in modern society which unfortunately according to the statistics, number of them is increasing.[1] These patients owe their life to chronic and acute dialysis. An acute dialysis can be done with embedding catheter in central vein, but in chronic hemodialysis, fistula or arteriovenous graft (AVG) is needed. Hence, the first step in creating chronic dialysis is a suitable vascular access to provide the output and input blood needed for dialysis that at least is 300 mL/min. The other issue is about the performance of vascular access that should be continues with minimized short- and long-term complications, and this was one of the main difficulties since the invention of dialysis in 1943 by Kolff *et al.* In 1966, the technique of fistula surgery between the radial artery and cephalic vein was described by Brescia *et al.*[2,3]

This method due to the high benefits and low complications is still accepted as a standard method of

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vascular access for patients with chronic dialysis. In spite of this and to reduce complications and better performance, different ways have been devised which include the use of autogenic artery and vein and graft. There are some agents involved with efficacy and complications of AVG such as age, peripheral vascular disease, the onset and length of dialysis and central catheters.[4] In general, with regard to the advancement of medical care and increase the longevity of the chronic renal failure patients in such a way the prevalence of kidney disease increase 7-9% yearly, the amount of fistula embedding and AVG are also increased.[5] The central catheters used in acute dialysis is considered as a center for infection, thrombosis and stenosis.[6] Arteriovenous fistula (AVF) is considered as the first step in choice hemodialysis patients but due to the lack of function in some patients with unsuitable superficial vein in obese and diabetic patients, the use of AVG is avoided. The graft embedment and rapid use of it is easy, but the results are not satisfactory in long term and the chance of primary function of graft in 12 months is <60%.[7,8]

Polytetrafluoroethylene is original substance in used grafts which is prone to malfunction due to the stenosis or obstruction. This stenosis usually occurs in the place of anastomosis.[9] The study about the determination of AVG survival rate was conducted in limited range in the world contrary to the study of AVF survival rate; there was no study about this subject in our country. In the study of Gao *et al.* in the far east, this rate was 50%,[10] while in the study of Davoudi *et al.* in Iran, the survival rate in the first year after embedding was 70%.[11] Regarding the vitality of hemodialysis in patients and according to increasing of hemodialysis, the first step is embedment of a vascular access to provide appropriate dialysis. The purpose of this study was to determine the survival rate of AVG and its numerous complications to avoid complications with early detection. Furthermore, due to the enormous costs of AVG and fistula, it is essential to identify the related factors with the lack of their function and found the appropriate method to prevent complications.

MATERIALS AND METHODS

In this study, 299 patients from September 2012 to September 2015 under AVG embedded in the operating room in Imam Khomeini Hospital were studied. All patients before kidney transplantation surgery were examined by kidney transplantation fellowship in terms of vascular status and location of previous AVF. AVG embedded in our center included brachial-axillary, arm loop and femoral. Our study patients included with previous failed AVF and patients who were not suitable for AVF embedded in terms of anatomy and those who were candidate at first. Demographic and clinical data of patients were extracted from outpatient files and by getting their history and were saved as a questionnaire. Patients after AVG embedding routinely 3 days, 2 weeks, and then monthly were followed. If needed during follow-up intervals due to investigate blood flow of AVG, color Doppler ultrasound was done. The duration of the follow-up was 1 year at least for each patient, and the duration of the study was 36 months. Patients who experienced the lack of function of the AVG in the same moment embedded as well as patients who were under the previous repair AVG were excluded from the study. Patients who died during the follow-up or underwent kidney transplantation surgery in the study were investigated. Survival or being open of AVG for 1 year were defined as a time that words for dialysis or lack of a palpable thrill in physical examination or reducing blood flow velocity to less than 400 cc per minute in Doppler ultrasonography. Due to the high cost of ultrasound, more patients were investigated on the basis of the first two subjects (palpable thrill in the examination or failing to do dialysis from AVG). Complications of AVG embedded in this study were evaluated and registered. To describe the qualitative and quantitative variables, frequency distribution, mean and standard deviation were reported. Cox regression was used to investigate the relationship between variables and survival time. Cox regression model is a semi-parametric model to fit the hazard function which can be added with explanatory variables or risk factors to the model but also baseline hazard function was uncertain as a function of the time constant but non-negative. Cox hazard function for X explanatory variable is a function as follows:

$$(\beta^{T}X)\ h(t|x)=h_0(t)\exp$$

Since β is vector of regression parameters and (exp) β^T X is a function of relative risk. Under this model, explanatory variables have multiplicative effect on the risk function and regression parameters interpreted as the logarithm of the relative risks.

Ethical Consideration

The permission to conduct the study was obtained from the Ethics Committee of our Institution.

RESULTS

The study is conducted with 299 patients who were undergoing hemodialysis with AVG from 2012 to 2014. The mean age of subjects was 62.87 ± 13. A total of 127 patients of the 299 patients were male and 172 patients were female. The frequency of AVG in different places among patients were as follows: (1) Left brachial-axillary 226 cases (75.6%), (2) right brachial-axillary 57 cases (19.1%), (3) femoral 12 cases (4%), and (4) arm loop 4 cases (1.3%) (Table 1).

A total of 111 (37.12%) patients of the 299 patients who were embedded AVG encounter with failure in

a period of 1-year. The mean of survival time was 35.088 with 95% interval confidence (32.82, 37.356). Median of survival time in our study was not calculated. Based on Kaplan–Meier plot almost after week 30 graft survival probability was constant and fixed, and in other words, the risk of graft rejection was reduced. Of 299 patients were studied, 112 had complication that the rate of complications in order of frequency was as follows: (1) Thrombosis, 53 patients (17.7%); (2) venous anastomosis stenosis of 19 patients (6.4%); (3) infection of graft, 17 patients (5.7%); (4) hematoma of graft place, 9 patients (3%); (5) venous congestion and edema, 7 patients (2.3%); (6) pseudoaneurysm, 6 (2%); (7) steal syndrome, 1 patient (3%). The frequency due to the prevalence of chronic renal failure in patients undergoing AVG was as follows: (1) Diabetes, 125 patients (41.8%); (2) hypertension, 100 patients (33.4%); (3) glomerulonephritis, 41 patients (13.7%); (4) chronic pyelonephritis, 14 patients (4.7%); (5) polycystic kidney disease, 13 (4.3%); (6) congenital renal atrophy, 2 patients (0.7%); (7) obstructive nephropathy, 2 patients (0.7%); (8) neurogenic bladder, 2 patients (0.7%) (Table 2).

In the case of risk factors relating to age, sex, number of the previous catheter for hemodialysis, fistula for dialysis and underlying disease, results taken as follows: The results above show that two variables age ($P = 0.007$) and number of catheters ($P = 0.002$) have effect on the time of survival, but the effect of two variables sex and number of fistula were significant in terms of survival time and above results show that for an increase every year in the age of the individuals, the rejection chance was 1.02-fold greater. The increase of every catheter, the rejection chance was 1.3-fold greater. To check the effect of the location of the graft on graft survival time, the location of the left brachial-axillary was considered as a reference because there is a greater frequency that the results summarized in Table 2. Based on the results of the cox regression, the place of catheterization had not effect on survival time. Although the results show that in the arm the chance of rejection was 2.25-fold greater compared to the place of the left brachial-axillary, it was not statistically significant. In the case of the effect of the underlying disease, according to the results based on the survival of associated cox regression, the chance of a rejection of grafts in people who had glomerulonephritis was 2.05-fold greater than diabetic patients ($P = 0.004$). Rest causes of kidney failure compared with diabetes had not a significant effect on the survival time.

Table 1: The frequency of arteriovenous graft in different places among patients

Type of fistula	Frequency (%)	Cumulative percent
Left brachial-axillary	226 (75.6)	75.6
Right brachial-axillary	57 (19.1)	94.6
Femoral	12 (4.0)	98.7
Arm loop	4 (1.3)	100.0
Total	299 (100)	

Table 2: The frequency due to the prevalence of chronic renal failure in patients undergoing arteriovenous graft

Comorbidities	Frequency (%)	Cumulative percent
Diabetes	100 (33.4)	33.4
Hypertension	125 (41.8)	75.3
Glomerulonephritis	41 (13.7)	89.0
Chronic pyelonephritis	13 (4.3)	93.3
Polycystic kidney	14 (4.7)	98.0
Congenital renal atrophy	2 (0.7)	98.7
Obstructive nephropathy	2 (0.7)	99.3
Neurogenic bladder	2 (0.7)	100.0
Total	299 (100.0)	

In the case of the survival of the 1 , 3, and 6 months of AVG, results show that of a total of 299 patients, 177 patients (59.2%) had functional graft after 1 month and 161 patients (53.8%) had functional graft after 3 months and 132 patients (44.1%) had functional graft after 6 months. The results of 1 year survival time showed that of a total of 299 patients, 130 (43.5%) had functional graft after 1 year.

DISCUSSION

In the case of the survival of the 1, 3, and 6 months of AVG, results show that of a total of 299 patients, 177 patients (59.2%) had functional graft after 1 month, 161 patients (53.8%) had functional graft after 3 months, and 132 patients (44.1%) had functional graft after 6 months. In the study of Gao *et al.,* in 2013, 1 year and 3 months survival rate was 50% and 96.7%, respectively; 1 year survival rate was almost like our study.[10] As well as in the study of Davoudi *et al.*, 1 year survival rate was 70%[11] and in the study of Charlton *et al.* was 64% ($P = 0.0001$)[12] that in both the 1 year survival rate was more than our study. In the study of Wongkonkitsin and Prasertcharoensuk, in 2014, 1 year survival rate was 63.94%.[13] As well as in the study of Dixon *et al.* in 2002, 1 year AVG survival rate was 54%.[14] It seems that the 1 year survival rate in our study was similar to some previous studies and in some cases lower than similar studies.

Complications after AVG embedding were as follows: (1) Thrombosis, 53 patients (17.7%); (2) venous anastomosis stenosis of 19 patients (6.4%); (3) infection of graft, 17 patients (5.7%); (4) hematoma of graft place, 9 patients (3%); (5) venous congestion and edema, 7 patients (2.3%); (6) pseudoaneurysm, 6 (2%); (7) steal syndrome, 1 patient (3%). In the study of Baghi *et al.*, amount of complications leading to failure were as follows in order: Thrombosis 24.4%, infection 4.8%, and pseudoaneurysm 4.8%.[15] In the study of Bachleda *et al.*, in

2015, common complications of graft were thrombosis, stenosis, and infection.[16]

In the study of Wongkonkitsin and Prasertcharoensuk, in 2014, infection 12% mentioned as the most common complication of graft.[13] As well as in the study of Helling *et al.* were infections, lower limbs edema and hematoma and steal syndrome in graft place mentioned as common complications.[17] Being inappropriate in venous vessels and having small diameter have effect on stenosis of anastomosis place. The infection rate in our study was similar to other studies and observe the sterility during operation until necessary care after operation and as well as the skills of the staff during the dialysis are effective in the prevention of infection.

The results of this study showed that two variables age ($P = 0.007$) and the number of catheterization ($P = 0.002$) had effect on survival time, but the effect of two variables gender and number of fistulas were not significant in survival time. The results showed that for an increase in every year of age in patients, the chance of rejection was 1.02 times and in every increase of catheter, the chance of rejection was 1.31 times or in other words for an increase in catheterization, the chance of rejection was 31% more. In the study of Thwaites and Robless, diabetes, age, sex, and previous catheterization had not effect on survival time.[18]

Also in the study of Chia *et al.* in 1999, diabetes had no effect on the infection rate.[19] Unlike the similar studies, the age can decrease that performance of graft due to atherosclerosis in the elderly and low quality of vessels in the elderly and also increase of underlying diseases along in this age and the lack of adequate care and referring to follow-up due to aging. In the case of the effect of sex on the survival, our study results were similar to other studies and sex had no effect on survival time.

Based on the results of the cox regression, the area of graft had not effect on the survival time. Although the results showed that the arm loop area can increase the chance of rejection compared to the left brachial-axillary 2.25-fold, this chance is not statistically significant. In the study of Mousa *et al.,* in 2013, also the area of graft had not effect on the survival.[9]

In the case of the effect of the underlying disease on the survival, according to the results based on cox regression, the chance of a rejection of grafts in people who have diabetes was 2.05 greater ($P = 0.004$). The rest causes of kidney failure compared with diabetes have not significant effect on the survival time. In the study of Thwaites and Robless, diabetes had not significant effect on the survival rate.[18] As well as in the study of Chia *et al.* in 1999, diabetes had not effect on infection.[19] In the study of Charlton *et al.*, as well as underlying diseases had not effect on the survival time.[12] As our study showed diabetes and glomerulonephritis had a negative effect on survival time. In the rest of the underlying diseases, there was no relationship on the survival rate.

CONCLUSION

If it is not possible to embed AVF in patients on dialysis, AVG embedded is an alternative and crucial method. Obviously, to prevent complications, related risk factors of reduction of survival rate can be identified and then lead to increasing of survival rate. Some conditions can be helpful to reduce the complications of graft and increase the survival rate such as training of staff in dialysis ward about how to perform dialysis from vascular access, training of patients about the regular visit after AVG embedding and their awareness about the complications of AVG, the use of new graft with less arterial diameter, early treatment of complications of AVG, precise attention in AVG embedding and technical principles of vascular anastomosis and the use of vessels with high quality and appropriate diameter. As well as patients' fallow-up with color Doppler ultrasound to decide the amount of blood flow can reduce the complication of stenosis and aneurysm. Due to the lack of the possibility of kidney transplantation in all patients on dialysis, the care of vascular access can be a significant role throughout the life of these patients. Regarding the destructive impact of some underlying diseases on the survival, the AVG embedding in these patients should be done with more precision for prevention of possible complications. Regarding the value of the vessels in dialysis patients, it is suggested to embed vascular access before the need to emergency dialysis because the emergency neck catheterization can be cause injury and reduce survival rate. Considering the importance of vessels in these patients, it is crucial to inform patients and staff in hospital to avoid unnecessary manipulations in vessels such as intravenous injection, serum therapy, and other procedures that lead to injure the vessels.

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