Vascular Access Profile in Maintenance Hemodialysis Patients

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Introduction. The aims of this study was to evaluate maintenance hemodialysis population in a tertiary care hospital based dialysis unit for vascular access (VA) types, to compare native arteriovenous fistula (AVF) and arteriovenous graft (AVG) survival, and to assess risk factors for access failure.

Materials and Methods. A total of 182 patients on maintenance hemodialysis were evaluated and followed up in terms of VA type and VA outcomes.

Results. Among 103 prevalent patients, 15.5% initiated dialysis with AVF. At the time of the study, 67.9% of the prevalent patients had an AVF and 29.1% had AVG. Of 79 incident patients, 64% were followed up for more than 3 months by nephrologists before initiation of dialysis. Among these patients, 13.6% were initiated with AVF. There were 25 primary failures and 50 secondary failure episodes. Of the 50 secondary failures, 15 were AVF failures and 31 AVG failures. Vascular access survival was significantly superior with AVF as compared with AVG ($P = .03$). With longer dialysis periods, failure rates were higher. Follow-up with nephrologists prior to initiation of dialysis had a major influence on VA.

Conclusions. Arteriovenous fistula is the best VA for maintenance hemodialysis. However, when the vasculature is not ideal for AVF, AVG should be constructed. A small percentage of our patients had fistula at initiation of dialysis. This is mainly due to late nephrology referrals and also due to reluctance of patients to undergo surgical access placement when they are relatively asymptomatic.

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INTRODUCTION

A well-functioning vascular access (VA) remains the Achilles heel of hemodialysis and is essential to providing efficient dialysis therapy.[1] Chronic maintenance hemodialysis requires stable and repetitive access to the vascular compartment in order to deliver high rates of blood flow to the extracorporeal circuit. There are 3 main types of access: native arteriovenous fistula (AVF), arteriovenous graft (AVG), and central vein catheter.[1]

Vascular access use varies widely across countries. To achieve the best possible patient outcomes in hemodialysis, it is widely accepted that the optimal vascular access device is a well-functioning AVF.[2] Various VA guidelines state clearly that for patients requiring chronic hemodialysis, the preferred type of access is a native AVF. Once an AVF has matured and been used for dialysis, the subsequent failure rate is low, with most patients enjoying long-term fistula function for many years.[3] Other hemodialysis access devices such as synthetic

AVGs and central venous catheters are known to have more problems with flow, morbidity, and increased cost compared with the AVF. Indeed, several recent studies show that there is a gradient of patient mortality risk by access type, with the highest risk observed with central venous catheters, and the lowest risk with AVFs.[2]

Timing of referral is often thought to be critical, as patients referred to renal services earlier have greater opportunities to access education programs, take part in clinical decisions regarding dialysis and transplantation, and start the renal replacement therapy of their choice via an established VA or peritoneal access route or by preemptive transplant. Exactly how far in advance patients should be referred in order to ensure the best outcomes has never been well established. Many studies have used 3 or 4 months, as a cutoff when examining the effects of late referral, though whether this is adequate remains uncertain.[4]

Inadequate preparation is associated with starting dialysis using a temporary catheter, which itself is associated with increased morbidity and mortality. Several studies have reported that a proportion of patients who have been known to the renal services for some time before starting dialysis still have urgent dialysis initiation through temporary VA.[4] The objective of our study was to determine practice patterns that are associated with better patient outcomes. The main aims of our study were to evaluate maintenance hemodialysis population in a tertiary care hospital based dialysis unit for VA types, to compare native AVF and AVG survival, and to assess risk factors for access failure.

MATERIALS AND METHODS

This study was a carried out to evaluate prevalent maintenance hemodialysis patients approached in January 2009 and incident patients approached from January 2009 onwards at Manipal hospital, Bangalore, India. All prevalent and incident maintenance hemodialysis patients undergoing were included in the study. Patients on dialysis for less than 4 weeks were excluded from this study. Both prevalent and incident maintenance hemodialysis patients were prospectively followed until June 2012. Primary VA failure was defined as a fistula which never matured adequately to be used successfully for dialysis. Secondary failure was defined as permanent failure of AVF after being used adequately for hemodialysis for at least 6 weeks.

Descriptive statistical analyses were carried out. Results on continuous measurements were presented as mean ± standard deviation and results on categorical measurements were presented as number (%). Single proportion binomial test was used to find the significance of incidence of failure in relation to various variables. A 95% confidence interval was calculated to find the significant features. The Kaplan-Meier analysis was done to calculate the mean survival rate of access type. The chi-square and Fisher exact tests were used to assess the significance of study parameters on categorical scale between two or more groups. A *P* value less than .05 was considered significant.

RESULTS

A total of 182 patients were enrolled in this study (67% men and 33% women), 103 of whom were prevalent and 79 were incident patients. The mean age was 54.64 ± 13.83 years (range, 8 to 86 years). Hemodialysis sessions were thrice weekly in 75% of the patients, twice weekly in 21.9%, and four times weekly in 2.7%. Of the study population, 94% were hypertensive, 42% had coronary artery disease, and 18% had peripheral vascular disease (Table 1). The mean body mass index (BMI) was 22.69 kg/m^2 (range, 13.22 kg/m^2 to 43.7 kg/m^2).

Of the 103 prevalent patients 72 were men (69.9%) and 31were women (31.1%). Among these patients only 15.5% were initiated with permanent access (AVF), while 84.5% were initiated with temporary catheters (Figure 1). At the time of the study, 67.9% of the prevalent patients had an AVF, of which 34.3% were brachial and 65.7% were radial fistulas; 29.1% had AVG; 1.9% had temporary catheters; and 0.9% had cuffed tunneled catheter. The 79 incident patients were enrolled from January 2009 to December 2011 (68.4% were men and 32% were women). Sixty-four percent of these patients were followed up for more than 3 months by nephrologists before initiation of dialysis. Among these patients, 13.6% were initiated with permanent access (AVF), while 86.4% were initiated with temporary catheters (Figure 1). Fifty-three percent of the patients had AVF with a mean time from construction to use of AVF being 52 days, and 19% had AVG construction, which was used after a mean time of

Table 1. Characteristics of Hemodialysis Patients

Characteristic	Value*
Mean age, y	54.64 ± 13.83
Sex	
Male	122 (67.1)
Female	60 (32.9)
Patient type	
Prevalent dialysis patient	103 (56.6)
Incident dialysis patient	79 (43.4)
Frequency of hemodialysis	
2 per week	40 (21.9)
3 per week	137 (75.3)
4 per week	5 (2.7)
Body mass index, kg/m2	
< 18.5	26 (14.3)
18.5 to 23.0	83 (45.6)
23.0 to 30.0	60 (32.9)
> 30.0	13 (7.4)
Comorbidity	
Diabetes mellitus	105 (57.7)
Hypertension	172 (94.4)
Coronary artery disease	76 (41.8)
Peripheral vascular disease	33 (18.1)
Cerebrovascular disease	11 (6.0)

*Values are frequencies (percentages) except for mean age.

20 days. Two patients underwent cuffed tunneled catheter placement, which was used soon after placement.

During the study period, 7 patients were lost for follow up (transferred to another center, underwent kidney transplantation, or died). During the follow-up period, there were 25 primary failures and 50 secondary failure episodes. Of the 50 secondary failures, 15 were AVF failures, 8 being brachial and 7 radial AVFs; 31 AVG failures; and 4 permanent catheter failures (Table 2). There were a total of 41 episodes of failures in diabetic patients and 34 in nondiabetic patients (not significantly different). Among the patients with primary failures, 7 were diabetic and 9 were nondiabetic, whereas among those with secondary failures, 18 were diabetics and 15 nondiabetic patients.

Vascular access survival was significantly superior with AVF as compared with AVG ($P = .03$; Figure 2) and in nondiabetic patients ($P = .02$; Figure 3). However, the same was not true in diabetic patients (Figure 4), where survival with AVF and AVG were comparable ($P = .80$). In the elderly population (age > 70 years) failure rates were significantly higher ($P < .001$; Table 3). Secondary failures were more frequent in smokers ($P = .005$); however, on multivariate analysis, it was not a

Table 2. Episodes of Secondary Failure by Vascular Access Types

Access	Number of Patients	Episodes of Failures (%)
Arteriovenous fistula	117	15 (12.8)
Brachial	47	8 (17.0)
Radial	70	7 (10.0)
Arteriovenous graft	48	31 (64.6)
Internal jugular vein	14	0
Permanent catheter	3	4 (100)
Total	182	50 (27.5)

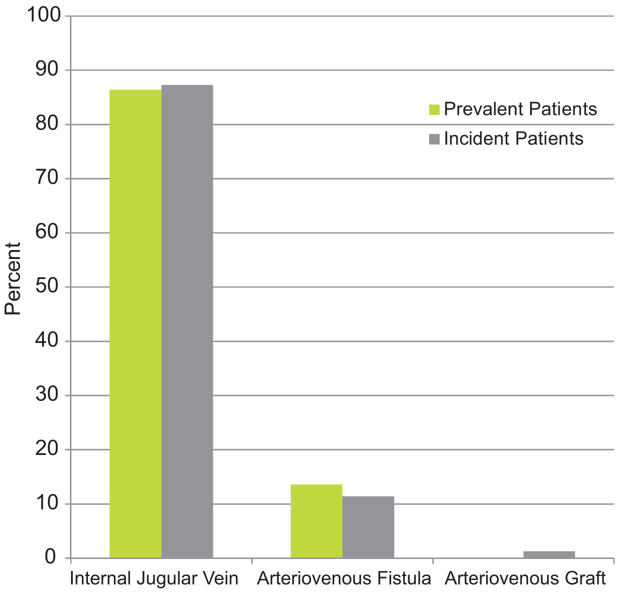

Figure 1. Type of vascular access in prevalent and incident patients at the time of initiation of hemodialysis.

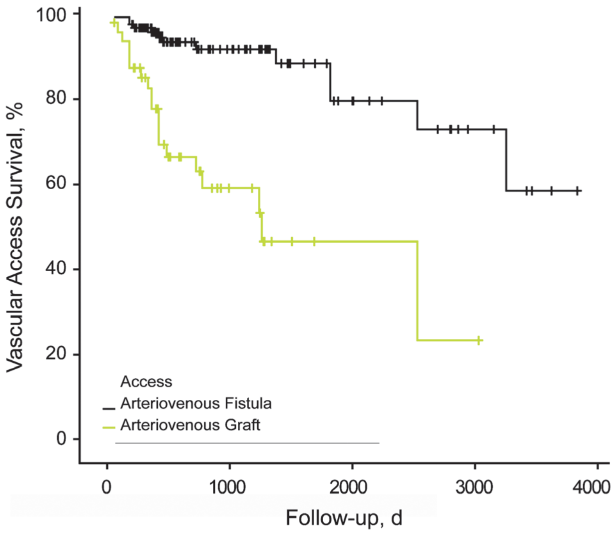

Figure 2. Survival analysis curves based on vascular access types.

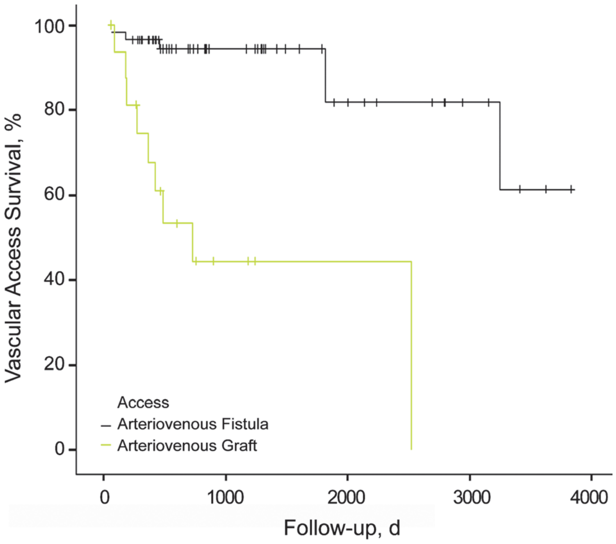

Figure 3. Survival analysis curves based on vascular access type in nondiabetic patients.

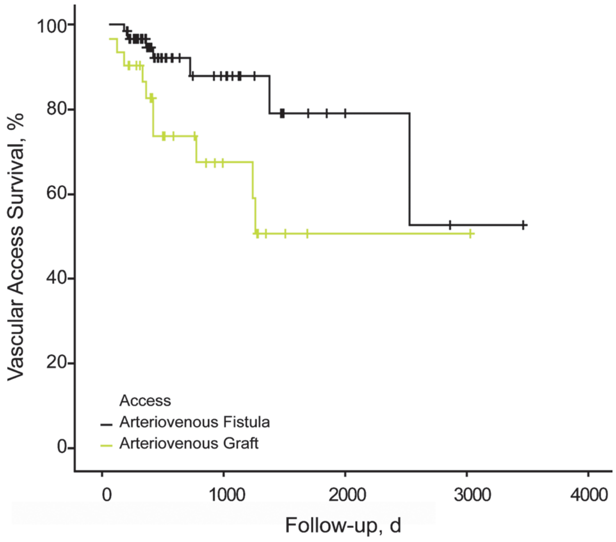

Figure 4. Survival analysis curves based on vascular access type in diabetic patients.

Table 3. Episodes of Secondary Failure by Age Distribution

Age, y	Number of Patients	Episodes of Failures (%)	*P*
< 50	61	19 (31.1)	.54
51 to 70	104	20 (19.2)	.41
> 70	17	11 (64.7)	< .001
Total	182	50 (27.5)	...

significant factor. The incidence of secondary failures was comparable between brachial and radial AVFs (*P* = .27).

Duration on dialysis had a bearing on the number of secondary failures (Table 4). When patients were on dialysis for longer periods, failure rates increased; with a duration on dialysis longer than 4 years, failure rate reached 56.4% (*P* < .001). The same finding was true among diabetics (*P* = .001), but not among nondiabetic patients. There were no significant differences in secondary failure rates based on sex, diabetes, body mass index, coronary artery disease, peripheral vascular disease, or cerebrovascular accidents in either univariable or multivariable analysis (Table 5). Follow-up with nephrologists prior to initiation of dialysis had a major influence on VA. Receiving nephrology care for longer than 3 months was associated with 16.2% initiating on dialysis through AVF versus 5.9% for shorter periods (*P* = .03; Table 6).

Table 4. Episodes of Secondary Failure by Duration of Dialysis in Diabetic Patients

Dialysis duration, y	Number of Patients	Episodes of Failures (%)	*P*
< 1	22	1 (4.5)	.02
1 to 2	39	7 (17.9)	.22
2 to 4	25	7 (28.0)	.87
> 4	16	12 (75.0)	< .001
Total	102	27 (26.5)	...

Table 5. Risk Factors for Predicting Secondary Failures in Multivariate Analysis

Risk Factor	Number of Patients	Adjusted Odds ratio	Standard Error	*P*
Age >70 years	17	3.95	0.600	.02
Female	60	2.29	0.565	.14
Smoking	71	1.89	0.541	.24
Coronary artery disease	76	1.55	0.453	.34
Body mass index > 25 kg/m^2	43	0.92	0.506	.88
Peripheral vascular disease	33	0.94	0.592	.91
Cerebrovascular accident	11	1.23	0.812	.81
Dialysis duration > 4 years	39	3.13	0.457	.01
Diabetes mellitus	102	0.82	0.443	.66

Table 6. Follow-up by a Nephrologist Before Dialysis Initiation

Follow-up, mo	Number of patients (%)	Hemodialysis Initiation Vascular Access		
		Internal Jugular Vein	Arteriovenous Fistula	Arteriovenous Graft
< 3	65 (34.1)	60 (92.3)	4 (6.1)	1 (1.5)
> 3	117 (64.3)	98 (83.8)	19 (16.2)	0
Total	182 (100)	158 (86.8)	23 (12.6)	1 (0.6)

DISCUSSION

This was a single-center VA profile study of prevalent and incident patients on maintenance hemodialysis. The mean age of patients receiving maintenance hemodialysis in most developing countries is much lower (32 to 42 years) than that in the developed world (60 to 63 years).[5-8] of our patients, 57% aged between 50 and 70 years, which is higher than that observed in other centers in India.[9] Two-thirds of the patients were men, which is similar to what other studies have reported,[10] whereas some have reported lower rates too.[11] The majority of our patients had diabetic nephropathy as the cause of end-stage renal disease. In the ANSWER study,[10] diabetics constituted 36% of the patient population. In the Dialysis Outcomes and Practice Patterns Study (DOPPS) II, the incidence of diabetes mellitus was 41%, 26%, and 52% in Canada, Europe, and the United States, respectively.[2]

The Disease Outcomes Quality Initiative guidelines recommend use of catheter in less than 10% and AVF in more than 65% for prevalent patients. In the ANSWER study,[10] 52% had AVF (31% radial and 21% brachial), 2% AVG, 16% permanent catheters, and 30% temporary catheters. Analysis of VA profile in our prevalent patients (n = 103) revealed that 67.9% had AVF as their access; 34.3% of these were brachial and 65.7% radial fistulas. In addition, 29.1% had AVG as their access, 1.9% had temporary catheters, and 0.9% had a permanent catheter. Initiation of hemodialysis was associated with temporary catheter in 86.4% and 87.3% of prevalent and incident patients in our study. Only 13.6% and 11.4% of prevalent and incident patients were initiated with AVF as access.

Vascular access use observed across the three separate phases of the DOPPS data from 1996 to 2006 showed wide variation across the 12 DOPPS countries, with a high proportion of AVF (> 70%) in Japan, Australia, New Zealand, and in the European countries (except for Belgium, the United Kingdom, and Sweden). The use of AVF was less frequent in the United States compared with other countries in DOPPS I (1996 to 2001), but increased from 24% in DOPPS I to 47% in DOPPS III (2005 to 2007). A trend towards greater AVF use was also observed in Australia, New Zealand, and the United Kingdom. Data from DOPPS III (2005 to 2007) indicate that 4% to 13% of hemodialysis patients are using synthetic or bovine grafts in all countries except the United States.[1] At the initiation of dialysis, only 26% of Canadian hemodialysis patients (2002 to 2004) and 18% of patients in the United States start dialysis with an AVF, as compared with 50% of incident hemodialysis patients using an AVF in Europe. Catheters accounted for 70% of all vascular access use by Canadian hemodialysis patients when initiating hemodialysis, compared with 46% in Europe and 66% in the United States.[2] Only 12.7 % of incident hemodialysis patients in our center were initiated with a permanent access.

Lee and coworkers[12] studied 110 patients and found the cumulative access survival was significantly longer for upper arm fistulas, as compared with grafts (median survival, 1524 days versus 517 days; *P* = .03). Hodges and colleagues[13] compared dialysis access patency rates and found that the primary patency rates of AVF and AVG were similar. After exclusion of fistulas that failed to mature, the AVF patency rate at 1 year improved from 43% to 54% (*P* = .09). Huber and colleagues[14] reviewed 34 studies predominantly composed of case series and nonrandomized controlled studies comparing autogenous and AVG accesses. They concluded that patency rate for autogenous upper extremity arteriovenous hemodialysis accesses appeared to be superior to that of AVG. Similarly, other authors noted that autogenous arteriovenous accesses were superior to AVG.[15,16] Ganesha and coworkers[17] concluded that autogenous accesses had superior primary patency and maintained equal secondary patency with significantly fewer interventions. We had a total of 75 failures, 25 primary failures and 50 episodes of secondary failure. Primary failure of AVF in our study was 21.4%, as compared to other studies which show a rate of 9% to 56%.[18-20] We found that AVF survival was far superior compared to AVG when the entire population was studied, with a median survival of 1011 days versus 705 days for AVF versus AVG, respectively. However, in the subgroup of diabetic patients, we found that survival of AVF and AVG were similar. In nondiabetic patients, AVF was superior to AVG.

Using multivariate analysis to look at various risk factors that could lead to access failure, we found that an age greater than 70 years, smoking, and longer duration on dialysis (> 4 years) had a positive correlation with access failure. However, presence of diabetes, female sex, cerebrovascular and peripheral vascular disease, and body mass index were not associated with secondary failures. Lee and coworkers[12] found on multivariate analysis that age, sex, diabetes mellitus, peripheral vascular disease, obesity, and pre-operative vascular diameters were not associated with increased secondary failures. Hodges and colleagues[13] also reported similar findings. In their study, a history of prior failed AVG was the only significant risk factor for failure of a subsequent AVG graft at a new site. Perera and associates[17] found no significant association of the above factors on either primary or secondary patency rates in both groups. Hayakawa and coworkers[21] reported that age was a risk factor for the successful maintenance of initial permanent hemodialysis vascular access. Gheith and colleagues observed that severe anemia, age, diabetes mellitus, and smoking were the main risk factors of VA failure.[22]

In the DOPPS,[1] the mean proportion of catheter use in new patients was 77% and 36% for patients seen by nephrologists for less than 1 month and for more than 4 months, respectively, before starting dialysis. High rate of catheter use was seen in new end-stage renal disease patients in Canada, although 85% of these patients were reported to have been seeing by a nephrologist for more than 1 month before starting dialysis, and 79% for more than 4 months prior to end-stage renal disease.[2] However, in our study follow-up of patients for more than 3 months by nephrologists was associated with a higher percentage of patients starting dialysis with a permanent access (AVF, 16.2 % versus 5.9%).

CONCLUSIONS

Arteriovenous fistula is the best VA for maintenance hemodialysis. However, when the vasculature is not ideal for AVF, AVG should be constructed. The Kidney Disease Outcomes Quality Initiative guidelines recommend use of fistula (> 60%) for initiation of hemodialysis. In our study, only 13.6% of prevalent and 11.4% incident patients had fistula at initiation of dialysis. This is mainly due to late nephrology referrals and also due to reluctance of patients to undergo surgical access placement when they are relatively asymptomatic.

CONFLICT OF INTEREST

None declared.

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