Permanent Vascular Accesses for Heamodyalisis – One Serbian Center Results

D. Jovanovic[1], B. Parapid[2], M. Stosovic[1], R. Naumovic[1] and V. Nesic[1]

[1]Institute of Urology and Nephrology and [2]Institute of Cardiovascular Diseases,
Clinical Center of Serbia, Belgrade, Serbia

Abstract

Background. Vascular accesses are a very important problem in patients (pts) on chronic hemodialysis (HD). So, we analyzed 110 patients (55 men) aged between 27 and 79 (54,5±12,3) years who were in our dialysis center from 1 to 21 (7,2±5,3) years. The aim of this study was to analyze a number of vascular accesses and their dependence on gender, age, underlying renal disease and duration of hemodialysis.
Methods. In all the analyzed patients 204 arteriovenous fistulae (AVF) and 33 prosthetic grafts (polytetrafluorethylene = PTFE) were created. There was no correlation between age and the number of AVF. However, significant correlation between duration of HD and the number of AVF (p≤0,05) as well as the number of aneurisms of AVF (p≤0,01) was found in all analyzed patients.
Results. The number of PTFE was higher in women (2 vs 31) but the number of aneurisms was higher in men (21 vs 15). Significant correlation between duration of HD and the number of aneurisms (p≤0,05) was found in men, while correlation between duration of HD and the number of PTFE (p≤0,05) was found in women.
Younger patients (< 65 yrs; n = 86) had higher mean number of AVF and PTFE, while elderly (> 65 yrs; n = 24) patients had higher mean number of aneurisms. Duration of HD affected the number of AVF (p≤0,05) in youngers and the number of aneurisms in both younger and elderly patients (p≤0,05).
After dividing patients according to various renal diseases we found that patients with nephroangiosclerosis (Nscl), glomerulonephritis (GN) and tubulointerstitialnephritis (TIN) had the highest mean number of AVF, while patients with diabetic nephropathy (DN), polycystic kidney disease (PKD) and TIN had the highest mean number of PTFE. Correlation between age and the number of AVF was found only in patients with PKD (p≤0,05).
Conclusions. In conclusion, AVF were equally present in men and women as well as younger and elderly patients. The greatest number of AVFs was noted in patients with Nscl, GN and TIN. The higher number of PTFE was found in women, youngers and those with DN, PKD and TIN and DN. Vascular access survival was better in men and younger patients.

Key words: vascular accesses, sex, age, underlying kidney disease

Introduction

Quinton-Scribner's invention of an arteriovenous (AV) shunt in 1960 marked the beginning of the era of chronic dialysis enabling repeated punctures in chronic renal failure patients (1). Infections and thrombosis which frequently occurred with AV shunts made them unsuitable for long-term use. In 1967, Brescia et al. described the creation of a native AV fistula, which remained the first choice of vascular access (2). For the patients in whom a native AV fistula is not feasible, various synthetic grafts (i.e. polytetrafluorethylene - PTFE) can be used. Nevertheless, complications of permanent vascular access like stenosis, thrombosis, infections and aneurisms are among the very important causes of morbidity and mortality in patients undergoing chronic hemodyalisis, representing 15-30% of all causes requiring their hospital treatment (3-5).
The aim of this retrospective study was to evaluate the number and type of permanent vascular accesses in our chronic hemodialysis patients, as well as the influence of gender, age, underlying renal disease and duration of hemodyalisis on their vascular access survival.

Patients and methods

One hundred and ten patients (55 men), aged between 27 and 79 (54.5±12.3) years, undergoing hemodialysis in our unit from 1 to 21 (7.2±5.3) years were analyzed.
All patients were divided into 2 groups according to the gender – Group 1: 55 men (M), mean age 52.44±12.28 years and Group 2: 55 women (W), mean age 56.74±12.13 years; and 2 groups according to age – Group 1: 86 patients < 65 years, mean age 50.31±10.31 years and Group 2: 24 patients > 65 years mean age 69.92±3.86 years.
Patients were divided in 6 groups according to the various renal diseases: glomerulonephritis (GN): 29; tubulointerstitialnephritis (TIN): 23; nephroangiosclerosis (Nscl): 11; polycystic kidney disease (PKD): 17; unknown renal disease (URD): 23; and miscellaneous group: diabetic nephropathy (DN) and others: 7 patients.
Statistical analysis. The results were expressed as mean ± SD. Correlation coefficients (Pearson's) between analyzed parameters were calculated. A p-value < 0.05 was assumed statistically significant at two tailed level.

Correspodence to: Dijana Jovanović, Institute of Urology and Nephrology, Clinic of Nephrology, Clinical Center of Serbia, 11 000 Belgrade, Pasterova 2, Serbia; E-mail: dijanaj@Eunet.yu

Results

An overall of 110 patients had a total number of 204 (1.85±1.63) AVFs, 33 (0.30±0.95) PTFEs and 33 (0.32±0.47) aneurisms. For the patients in whom a native AV fistula was not feasible, synthetic grafts (PTFE) were used.

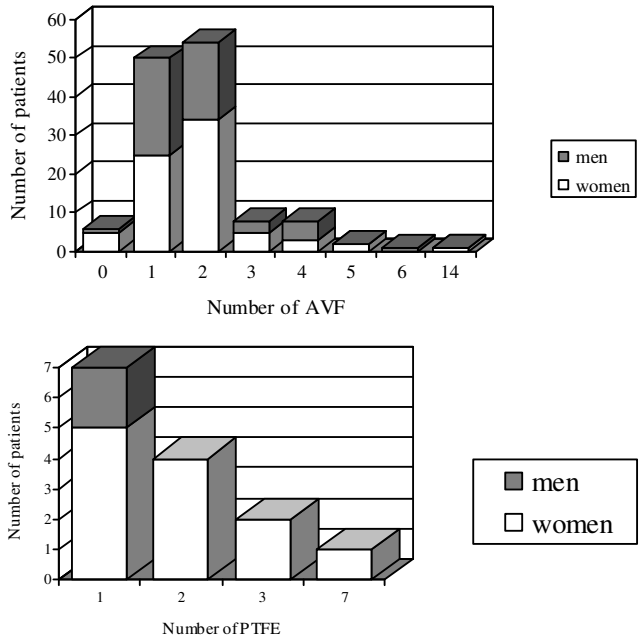

Figure 1. a) Distribution of arteriovenous fistulas (AVFs) and b) polytetrafluorethylene (PTFE) grafts in all analyzed patients on chronic hemodialysis

Number of AVFs were similar in both sexes (M : W = 100 vs 104 = 1.82±1.10 vs 1.89±2.03), whereas women had significantly more PTFEs (M : W = 2 vs 31 = 0.03±0.18 vs 0.56±0.29; $p<0.0033$). Men had a greater number of aneurisms (M : W = 21 vs 15 = 0.38±0.49 vs 0.27±0.45) which was not statistically significant ($p<0.222$).

The greater number of patients had one or two AVFs (Fig 1a), but there were, also, patients with 5, 6 or 14 fistulas (in 2, 1 and 1 patient, respectively). Fistulas were equally present in both sexes, except for a greater number of women having 2 and 4 AVFs and a case of a woman with creation of 14 fistulas. Fourteen patients (12.7%) had PTFEs: 2 men and 12 women (Fig 1b). The majority of patients had one or two PTFEs, but one woman had the maximum number of 7 PTFEs.

According to their age, the patients were also divided into 2 groups. Patients younger than 60 years had 162 (1.88±1.73) AVFs and 30 (0.35±1.04) PTFEs, whereas older had 42 (1.75±1.19) AVFs and 3 (0.12±0.45) PTFEs. Aneurisms were present in 25 (0.29±0.46) younger and 11 (0.46±0.51) elderly patients. There was no statistically significant difference between analyzed features in different age groups.

Underlying kidney disease and the number of vascular accesses in analyzed patients is shown in Figure 2. The highest number of vascular accesses was noted in patients with glomerulonephritis and tubulointerstitial nephritis. The greatest percent of PTFEs was found in the miscellaneous group of patients which was preponderantly represented by diabetic nephropathy, in patients with polycystic kidney disease and TIN.

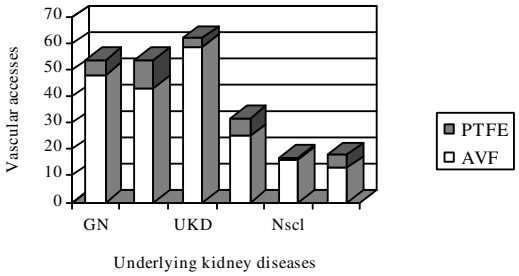

Figure 2. Distribution of vascular accesses: arteriovenous fistulas (AVF) and polytetrafluorethylene (PTFE) grafts in analyzed patients divided according to underlying kidney diseases (GN – glomerulonephritis, TIN – tubulointerstitialnephritis, Nscl – nephroangiosclerosis, PKD - polycystic kidney disease, URD - unknown renal disease, Others - diabetic nephropathy and others)

Significant correlations between the age and number of AVFs/PTFEs as well as the duration of dialysis and number of fistulas/prostheses/aneurisms in all patients and their sub-groups are shown in Table 1.

Table 1. Significant correlation in all analyzed patients and described sub-groups according to gender, age and underlying kidney disease

Correlation	r	*P*
All patients		
Time on dialysis vs. Number of fistulas	r=0.231355	<0.05
Time on dialysis vs. Number of aneurisms	r=0.278568	<0.01
Gender-related subgroups		
Time on dialysis vs. Number of fistulas	R_w=0.34327	<0.05
Time on dialysis vs. Number of aneurisms	r_m=0.342716	<0.05
Age-related subgroups		
Time on dialysis vs. Number of fistulas	r_y=0.25139	<0.05
Time on dialysis vs. Number of aneurysms	r_y=0.308668	<0.05
	r_o=0.437602	<0.05
Underlying kidney disease- related subgroups		
Age vs. Number of fistulas	r_{PKD}=-0.55551	<0.05

Legend: r – correlation coefficient, w – women, m – men, y – younger, o – old, PKD – polycystic kidney disease

Analyzing the presence of vascular accesses (AVF and PTFE) per year and per 1000 months of dialysis we came to the following results: in all patients, one vascular access was present per 3.34 years, 25 per 1000 patients months on

hemodialysis (Table 2); survival of vascular accesses was better in men and in youngers; survival of AVFs was better than PTFEs (20.5/1000 vs 34.4/1000 patients months on hemodialysis).

Table 2. Correlation between the number of vascular accesses and time on dialysis

	All	M	W	Y	O	AVF	PTFE
1 vascular access/ dialysis years	3.34	3.98	2.87	3.50	2.65	4.03	2.42
No vascular access/ 1000 dialysis months	25.0	21.0	29.0	24.0	31.5	20.5	34.4

Legend: m – men, w – women, y – younger, o – old, AVF – arteriovenous fistula, PTFE – polytetrafluorethylene graft

Discussion

The invention of permanent vascular accesses represented an important success during the 1960's. Arteriovenous vascular accesses for hemodialysis (AVFs, grafts) provide a better flow, than temporary vascular approaches: Quinton-Scribner's arterio-venous shunts which are not in use any more as well as the central venous catheters (CVC) (6), and they have a lower frequency of thrombosis (7), infections (8), septicemia (9) and central venous stenosis development (10). In order to avoid the use of CVCs, it is necessary to provide the patient with an AV access before the beginning of dialysis (11,12).

In spite of advances in vascular surgery, the provision and maintenance of hemodialysis vascular access remains the Achilles' heel of dialysis care. The most frequent complications of permanent vascular accesses for hemodialysis are stenosis, infections, thrombosis and aneurism formation. Since all the above-mentioned are associated with decreased dialysis efficiency, increased morbidity and mortality of patients on chronic hemodialysis treatment and represent some 15-30% of indications for their hospital admissions, maintaining the usefulness of the vascular access, is of a great importance (3,4,13-15).

Venous stenoses are caused by neointimal and fibromuscular hyperplasia leading to thrombosis of the vascular access (15-19). The causes of hyperplasia are still a subject to investigation, yet many scientists report the cascade of events as a response to injury. Since turbulent blood flow is probably the initiating event, a new graft with a minimized turbulence might be a solution. Yet, it is considered that a new injury must occur first in order to initiate the cascade of events. Himmelfarb and co-workers (18) described platelet derived cytokines as a key factor which stimulate the damage cascade.

Risk factors for survival of AV access for hemodialysis are numerous. Woods et al. emphasize age as a majorrisk factor for development of AVF complications, but not for PTFEs (20) opposing to Astor et al. (14) who found that patients over 65 had the same risk of vascular accesses (AVFs and PTFEs) complications. Over the last two decades, it was proved that women develop more AVF complications than men (4,21-24), but, there are still controversial reports (19,23,24). Ifudu et al. describe that the majority of complications in women are due to the gender-based differences in hemostasis (21). Complications of the first vascular access more likely occur in men with a PTFE and women with AVF and PTFE than men with AVF. Furthermore, more frequent complications are reported in African Americans (13,14) and smokers (13). Women have in general more grafts (14,27) which are in accordance with our results (Fig 2), which can be explained by the gender-based differences, age and underlying kidney disease. Younger population, men and Caucasians have fistulas more often, while older, women and African Americans tend to have more grafts (28).

Independent predictors for dysfunction of fistulas are accelerated atherosclerosis, peripheral vascular diseases, metabolic disorders (diabetes, insulin resistance, hiperlipidemias, etc.), disorders of hemostasis, but also the duration of dialysis and erythropoietin therapy (13,26). Nevertheless, differences in vessel diameter – venous size – represent a significant predictor for fistula survival (26).

Although it is believed that among other issues, increased dialysis frequency leads to an increase in fistula-related complications, Quintaliani et al. failed to agree (13). The fistula survival wasn't less in daily dialysed patients in comparison with those on a three-times-a-week regimen, to whom our patients were scheduled as well.

The time of creation of AV access is of a great importance (at least a month prior dialysis start) as well as its development interval, especially in women (12). Women and older patients – who represent high risk group – require more frequent controls during the first months after beginning of dialysis (the first 3 months), but also, these patients need more time to for their AVF to mature (14). Some other factors also play an important role in vascular access survival: previous patient's conditions, surgical techniques, fistula maintenance and care, nutrition, coagulation factors and staff experience in puncturing of vascular approaches (12,24).

Arteriovenous fistulas last longer than grafts (3,27,29), the dialysis adequacy is better, infection and thrombose rates are lesser and their maintenance cheaper (4,6,13,14,17,28,30-33). Our patients, as well, showed longer survival for AVFs compared to PTFEs (Table 2). Quintiliani et al. (13) showed fistulas survival of above 6 years: 88% after 12 months and 75% after 24 months; Bonalumi et al. described that fistula survival was 83% after 12 months and 46% after 78 months (34). When complication rate is expressed as a number of events in 1000 patient months of hemodialysis, Quintiliani et al. (13) and Winsett & Wolma (35) reported similar results: 6.8 events (95%) vs. 5 events in 1000 patient months, respectively. This is lower than 37/1000 patient months found with PTFEs. The number of events per 1000 patient months was significantly higher, being even 25 in our patients (Table 2). Women presented more complications (29 vs. 21/1000), as well as the older patients (31.5 vs. 24). Grafts-wise, we had better results than Quintaliani's team (13): 37/1000 vs. 34.4/1000, respectively.

In all patients, we analyzed correlations between patient age and number of fistulas/prostheses; time on dialysis and number of fistulas, prostheses and aneurisms in all patients,

in patients divided into respective groups according to gender, age and underlying kidney disease. Significant correlations are presented in Table 1. Significant positive correlation between duration of dialysis and number of fistulas ($p<0.05$) and aneurisms ($p<0.05$) was found in all analyzed patients. A significant correlation was found between duration of hemodialysis and number of fistulas in younger patients ($p<0.05$), while duration of dialysis and number of aneurisms was statistically significant in both younger ($p<0.05$) and older ($p<0.05$) patients. Analyzing patients with various kidney diseases we found only correlation between age and number of AVFs in patients with PKD ($p<0.05$).

Conclusion

Arteriovenous fistulas were equally present in men and women as well as in younger and elderly patients. The greatest number of AVFs was noted in patients with nephroangiosclerosis, glomerulonephritis and TIN. The higher number of PTFE was found in women, younger patients and those with PKD, TIN and diabetes nephropathy. Older patients had more aneurisms. Vascular access survival was better in men and younger patients.

References

1. Quinton WE, Dillard D, Scribner BH. Cannulation of blood vessels for prolonged hemodialysis. *Trans Am Soc Artif Intern Organs* 1960; 6: 104-113
2. Brescia MJ, Cimino JE, Appel K, Hurwich BJ. Chronic hemodialysis using venipuncture and a surgically created arteriovenous fistula. *N Engl J Med* 1966; 275: 1089-1092
3. Chazan JA, London MR, Pono LM. Long-Term Survival of Vascular Accesses in a Large Chronic Hemodialysis Population. *Nephron* 1995; 69: 228-233
4. Feldman H, Held PJ, Hutchinson JT, et al. Hemodialysis vascular access morbidity in the United States. *Kidney Int* 1993; 43: 1091-1096
5. Konner K. Hystory of vascular access for haemodialysis. Nephrol Dial Transplant 2005; 20:2629-2635.
6. Fan PY, Schwab SJ. Vascular access: Concepts for the 1990s. *J Am Soc Nephrol* 1992; 3: 1-11
7. Twardowski ZJ. Percutaneous blood access for hemodialysis. *Semin Dial* 1995; 8: 175-186
8. Naumović RT, Jovanović DB, Djukanović Lj. Temporary vascular catheters for hemodialysis: a – 3 year prospective study. *Int J Artif Organs* 2004; 27 (10): 848-854
9. Powe NR, Jaar B, Furth SL, et al. Septicemia in dialysis patients: Incidence, risk factors, and prognosis. *Kidney Int* 1999; 55: 1081-1090
10. Hernandez D, Diaz F, Rufino M et al. Subclavian vascular access stenosis in dialysis patients: Natural history and risk factors. *J Am Soc Nephrol* 1998; 9: 1507-1510
11. National Kidney Foundation: DOQI Clinical Practice Guidelines for Vascular Access. *Am J Kidney Dis* 1997; (Suppl 3) 30: S150-S191
12. Astor BC, Eustace JA, Powe NR et al. Timing of Nephrologist Referral and Arteriovenous Access Use: The CHOICE Study. *Am J Kidney Dis*. 2001; 38 (3): 494-501
13. Quintaliani G, Buoncristiani U, Fagugli R et al. Survival of vascular access during daily and three times a week hemodialysis. *Clin Nephrol* 2000; 53 (5): 372-377
14. Astor BC, Coresh J, Powe NR, et al. Relation Between Gender and Vascular Access Complications in Hemodialysis Patients. *Am J Kidney Dis* 2000; 36 (6): 1126-34
15. Butterly D, Schwab SJ. Reducing the Risk of Hemodialysis Access. *Am J Kidney Dis* 1999; 34 (2): 362-363
16. Schwab SJ. Hemodialysis vascular access. *Kidney Int* 1999; 56: 1-17
17. National Kidney Foundation: DOQI Clinical Practice Guidelines for hemodialysis vascular access. *Am J Kidney Dis* 1997; (Suppl 3); 30: S150-191
18. Himmelfarb J, Couper L. Dipiridamole inhibits PDGF and BFGF-Induced vascular smooth muscle proliferation. *Kidney Int* 1997; 52: 1671-1677
19. Sukhatme V. Vacular access stenosis: Prospects for prevention therapy. *Kidney Int* 1996; 49: 1161-1174
20. Woods JD, Turenne MN, Strawderman RL et al. Vascular access survival among incident hemodialisis patients in United States. *Am J Kidney Dis* 1997; 30: 50-57
21. Ifudu O, Mayers JD, Cohen LS et al. Correlates of vascular access and nonvascular access-related hospitalization in hemodialysis patients. *Am J Nephrol* 1996; 16: 118-123
22. Golledge J, Smith CJ, Emery J, et al. Outcome of primaty radiocephalic fistula for haemodialysis. *Br J Surg* 1999; 86: 211-216
23. Feldman HI, Kobrin S, Wasserstein A. Hemodialysis vascularaccess morbidity. *J Am Soc Nephrol* 1996; 7: 523-535
24. Ernandez T, Saudan P, Berney T, et al. Risk factprs for early failure of native arteriovenous fistulas. *Nephron Clin Pract* 2005; 101: c39-44
25. Rocco MV, Bleyer AJ, Burkart JM. Utilization of inpatient and outpatient resources for the management of hemodialysis access complications. *Am J Kidney Dis* 1996; 28: 250-256
26. Reilly DT, Wood RF, Bell PR. Prospective study of dialysis fistulas: Problem patients and their treatment. *Br J Surg* 1982; 69: 549-553
27. Hirth RA, Turenne MN, Woods JD et al. Predictors of type of vascular access in hemodialysis patients. *JAMA* 1996; 276: 1303-1308
28. Sehgal AR, Silver MR, Covinsky KE, et al. Use of Standardized Ratios to Examine Variability in Hemodialysis Vascular Access Across Facilities. *Am J Kidney Dis* 2000; 35 (2): 275-281
29. Goldwasser P, Avram MM, Collier JT, et al. Correlates of vascular acess occlusion in hemodialysis. *Am J Kidney Dis* 1994; 24: 785-794
30. Hakim R, Himmelfarb J. Hemodialysis access failure: A call to action. Kidney Int 1998; 54: 1029-1040.
31. Sehgal AR, Snow RJ, Singer ME et al. Barriers to adequate delivery of hemodialysis. *Am J Kidney Dis* 1998; 593-601
32. Rayner HC, Pisoni RL, Gillespie RW, et al. Creation, cannulation and survival of arteriovenous fistulae: Data

from the Dialysis Outcomes and Practice Patterns Study. *Kidney Int* 2003; 63: 323-330

33. Rayner HC, Besarab A, Brown WW, et al. Vascular access results from the Dialysis Outcomes and Practice Patterns Study (DOPPS): performance against Kidney Disease Outcomes Quality Initiative (K/DOQI) Clinical Practice Guidelines. *Am J Kidney Dis*. 2004; 44 (5 Suppl 2): 22-26
34. Bonalumi U, Civalleri D, Rovida S, et al. Nine years' expirience with and-to-end arteriovenous fistula at the "anatomical snuffbox" for maintenance haemodialysis. *Br J Surg* 1982; 69: 486-488
35. Winsett OE, Wolma FJ. Complications of vascular access for hemodialysis. *South Med J* 1985; 78: 513-517