ORIGINAL ARTICLE

Radial artery internal diameter as a predictor of early failure of arteriovenous fistula in haemodialysis patients

Muhammad Rafiq Afridi, Muhammad Imran Khan, Jawad Khalil, Mohammad Zarin, Asif Malik, Raza Hassan

Abstract

Objective: To determine the effect of internal diameter of radial artery on arteriovenous fistulae (AVF) outcome in haemodialysis patients in terms of early AVF failure.

Study Design: This was a prospective study.

Setting & Duration: This study was carried out at Urology Department, The Institute of Kidney Diseases (IKD), Hayatabad, Peshawar, from June 2009 to Nov 2009.

Methodology: A total of 32 consecutive patients with End Stage Renal Diseases (ESRD), needing AVF for hemodialysis, were enrolled in this study. All the patients were evaluated by history, clinical examination and duplex ultrasound. Patients were divided into two groups, A and B (16 patients in each group). In group A the radial artery internal diameter was less than 2 mm and in group B it was 2 to 5 mm. All the patients were subjected to radiocephalic end to side AVF construction. Percentages were calculated for categorical variables while numerical variables were expressed with Mean ± SD with X2 and student t test being the tests of significance, respectively. Probability < 0.05 was considered significant.

Results: The mean age of patients was 39.50 ± 10.04 years in group A and 37.38 ±11.91 years in group B (P = 0.590). There were 9 (56%) males and 7(44%) females in group A compared to 11 (69%) males and 5 (31%) females in group B (P = 0.716). In group A, 7 (43.7%) had a successful fistula compared to 13 (81%) patients in group B (P = 0.02).

Conclusion: There is a high failure rate of AVF with radial artery diameter < 2mm. In the presence of small radial artery, proximal (upper arm) should be considered for fashioning AVF.

Key words: End staged Renal Diseases, Hemodialysis, Duplex U/S.

Institute of Kidney Diseases
Hayatabad Medical Complex, Peshawar
MR Afridi
MI Khan
A Malik

Khyber Teaching Hospital, Peshawar
J Khalil
M Zarin
R Hassan

Correspondence:
Dr. Muhammad Rafiq Afridi
House No 123, Street No 7, Sector E1, Phase 1
Hayatabad, Peshawar.
Cell no: 0333-5930707
Email Add: drafridi222@hotmail.com

Introduction

The preferred method for haemodialysis access in patients with end stage renal disease (ESRD) is arteriovenous fistula (AVF) due to its lower complications, longer survival and patency rate.[1,2] The first choice for native AVF is the Radiocephalic followed by brachiocephalic, brachiobasilic or forarm arteriovenous graft, in order of preference.[3] Despite the higher failure rate, radiocephalic fistula is still the first choice for haemodialysis due to the ease of placement and the preservation of proximal vessels for future access.[5-7]

Early failure of fistula is defined as a fistula that is never usable for dialysis or fails with in three months of initial use.[8] The two most common reasons for early AVF failure are stenosis and accessory veins.[9,10] Patient factors such as age, gender and BMI have no significant effect on early fistula failure.[11]

Colour Duplex ultrasound (DUS) scans are non-invasive, inexpensive and an excellent modality for evaluation of the anatomical and physiological aspects of the blood vessles. In addition, it gives valuable information in patients who have immediate fistula dysfunction and identifying patients who are at risk of future access failure.[12] Doppler ultrasound findings, internal diameter

of arteries and veins, shows good preoperative and perioperative correlatation.[13]

Various studies have shown a positive relationship between arterial diameter and fistula patency[14]. There is, however, no consensus as yet as to what should be the cut off value regarding internal diameter of the radial artery for successful outcome in AVF[13].

The purpose of this study, therefore, is to evaluate the effect of internal radial artery diameter on the outcome of fistula maturation. Based on the results of this study (by comparison of the two groups) a recommendation can be made regarding the ideal size (internal diameter) of radial artery for achieving a successful fistula.

Materials and methods

This prospective study was carried out at Institute of Kidney Diseases, Hayatabad Medical Complex, Peshwars, from June 2009 to November 2009. The aim of the study was to determine the effect of internal diameter of the radial artery (IDA) on arteriovenous fistula outcome in terms of early failure. A total of 32 consecutive patients, referred from nephrology department IKD with end stage renal disease (ESRD), needing AVF for dialysis, were included prospectively in the study. The exclusion criteria were patients with previously operated for the same procedure, thrombosed cephalic veins (determined on duplex ultrasonography).

The selected patients were evaluated through detailed history, examination and investigation. The radial artery was examined clinically to mark the direction and exact position of the vessels followed by preoperative duplex ultrasonography (DUS).

Pre-operative duplex ultrasound was performed on each patient with NEMIO SSA-550 machine by Toshiba. 7.5 MHz linear probe, model PLM-703 AT, was used to assess the radial artery diameter and patency. Flow was calculated by formula; F = Vav x Area x 60 (ml/ min). Venous thrombosis was also excluded with duplex ultrasound. All the DUS were performed by a single operator to ensure consistency of the measurements and exclude bias in the study results.

The patients were divided into two groups. Group "A" patients with radial artery internal diameter (IDA) < 2mm and Group "B" radial artery internal diameter ≥ 2mm. This cut off value of 2mm has been previously reported in the literature with a great majority of patients with failed AVF having IDA less than 2mm[15].

All the patients were subjected to radicephalic AVF (end of cephalic vein to side of radial artery). Surgical construction of the AVF was performed on out patient basis under local anaesthesia, 1% lignocaine. After local anaesthetic infiltration, a 4 to 5 cm longitudinal incision was given over the distal radial artery at the wrist. Both the cephalic vein and radial artery were dissected and an end to side anastomosis was fashioned using non absorbable monofilament suture material (prolene 7/0). Skin stitches were removed after 10 days. A single experienced surgeon performed all the procedures.

Postoperatively, DUS was performed in all operated patients on 1st post operative day and 1 week. The patency and flow rate were checked. Flow ≥ 400 ml/min was taken as good flow. Specific complications like hematoma, thrombosis and pseudoaneurysm were excluded. In case of low flow or thrombosis, no further follow up was carried out. While in patients with good functioning AVF, they were further followed up at 4 and 12 weeks.

Statistical analysis

The data was analyzed using SPSS version 15.0. The continuous variables were represented by mean ± standard deviation while frequency and percentages were calculated for categorical variables. Chi square test was used to compare the categorical variables like gender, internal artery diameters, in both the groups while student t test was used to compare the numerical variables, age, using 95% confidence interval. A two tailed P value equal to or less than 0.05 ($P \leq 0.05$) was considered significant. The data was presented in the form of tables and charts.

Results

A total of 32 patients were analyzed (16 patients in each group). The two groups were comparable for age and gender. The mean age of the patients was 39.50 ± 10.04 years in group A compared to 37.38 ±11.91years in group B. There were 9 (56.25%) males and 7 (43.75%) females patients in group A with a male to female ratio of 1.2:1 while there were 11(68.75%) males and 5(31.25%) females in group B with a male to female ratio of 2.2:1, as shown in table 1.

Out of the two groups (32 patients), 20 (62.5%) patients had a good functioning (successful) AVF compared to 12 (37.5%) patients with nonfunctioning AVF.

There were 9 (45%) females and 11 (55%) males in patients with the successfully constructed fistulas while the corresponding proportion in failed group were 3 (25%) and 9 (75 %) respectively, which was statistically insignificant (P = 0.25).

As shown in table 2, 7 (43.7%) patients in group A had a good functioning AVF compared to 13 (81.25%) patients in group B, which proved to be significant statistically (P = 0.02).

Table 1: *Patient demographics*

	Group A n(%)	**Group B n(%)**	**P Value***
Age (y)			0.590
Mean	39.50	37.38	
SD	10.04	11.91	
Gender			0.716
Female	9 (56.25)	11 (68.75)	
Male	7 (43.75)	5 (31.25)	

Table 2: *Outcome of arterivenous fistulae*

	Group A n(%)	**Group B n(%)**	**P Value***
Outcome			0.02
Successful	7 (43.7)	13 (81)	
Failed	9 (56.3)	3 (19)	

Table 3: *Outcome stratification according to gender*

	Male n(%)	**Female n(%)**	**P Value***
Outcome			0.24
Successful	11 (55)	9 (45)	
Failed	9 (75)	3 (25)	

Discussion

Native arteriovenous fistula (AVF) is currently deemed the best modality for hemodialysis access in patients with end stage renal disease (ESRD) by the national kidney foundation disease outcomes quality initiative (NKFK/DOQI) vascular access guidelines[16]. There were however, failure in fistulae, about 28-53%, to adequately mature necessary for dialysis support[9,17,18]. According to NKFK/DOQI guidelines, it is recommended to do preoperative duplex ultrasonography (DUS) in patients entitled to undergo AVF consrtuction[19]. Duplex ultrasonography is a non-invasive investigation for evaluation of vascular status and it can be used to predict and identify patients who are at increased rick of having failed AVF[12].

Vessel quality is believed to be an important factor predicting creation of a successful AVF[14]. A calcified atherosclerotic radial artery, a finding commonly observed in old age, with thickened wall and small diameter lumen rarely helps maintain an adequate arterial inflow for hemodialysis[13,20]. In our study, age was not found to be a predictive factor for fistula failure. This finding is endorsed by previously published studies[19,21]. Miller et al reported, in contradistinction with our reports, that age above 65 years was a predictive variable to failure of an AVF[13,17]. A possible reason for this could be that the patients in our study were on average younger to patients in some of these studies.

In this study, there was no statistically significant difference in fistulae failure rate when male and female gender were compared. Lauvao et al, in a retrospective review, did not find gender as a significant predictor of fistulae failure, similar to our findings[19]. In other studies, in contrast to our results, it was reported that female gender was associated with higher failure rate compared to males which was statistically significant[13,17].

The internal diameter of the radial artery has important implications so far early success of an AVF is concerned[14]. There is still an ongoing de-

bate, regarding the cut off value of internal diameter of radial artery, for achieving a successfully functioning fistula[13]. In our study radial artery internal diameter more than 2mm significantly predicted a successful outcome. The success rate in our study, with IDA less than 2mm, was 43.7%. In two prospective studies, the failure rate in patients with IDA less than 1.5 mm was 45.5% and 45%[12,14]. In another study the cut off value for successfully functioning fistulae was 4mm.

We would like to acknowledge the limitations in our study. First, the sample size was small and the results cannot be generalized. Second, our follow up period was short which could limit the number of patients with failed arterivenous fistulae (AVF), thereby, producing bias in the study results.

Conclusion

Internal diameter of the radial artery has a positive influence so far success of an arteriovenous fistula is concerned. Our study concludes that preoperatively determined radial artery internal diameter is the major predictor for a successful fistula. In our study patients with IDA more than 2mm had a better outcome in terms of a functioning fistula compared to patients with IDA less than 2mm which was statistically significant.

We therefore, recommend that in patients with IDA less than 2mm, a primary upper arm arteriovenous fistula should be the preferred option.

References

1. Perera GB, Mueller MP, Kubaska SM, Wilson SE, Lawrence PF, Fujitani RM. Superiority of autogenous arteriovenous hemodialysis access: Maintenance of function with fewer secondary intervention. Ann Vasc Surg 2004; 18: 66-73
2. Huber TS, Carter JW, Carter RL, Seeger JM. Patency of autogenous and polytetrafluoroethylene upper extremity arteriovenous hemodialysis access: A systemic review. J Vasc Surg 2003; 38: 1005-11
3. Lannery S. Lauvao, Daniel M. Ihnat, Kaoru R. Goshima, LeAnn Chavez, Angelika C. Gruessner, Joseph L. Mills Sr, Tucson, Ariz. Vein diameter is the major predictor of fistula maturation. J Vasc Surg 2009; 49: 1499-1504
4. Akram M, Bashir EA. Vascular access for hemodialysis. Pak Armed Forces Med J Dec 2007;57(4):253-7
5. Rooijens PP, Tordoir JH, Stijnen T, Burgmans JP, de Smet AA, Yo Ti. Radiocephalic wrist arteriovenous fistula for hemodialysis. Meta analysis indicates a high primary failure rate. Eur J Vasc Endovasc Surg 2004; 28: 583-89
6. Wong V, Ward R, Taylor J, Selvakumar S, How TV, Bakran A. Factors associated with early failure of arteriovenous fistula for hemodialysis access. Eur J Vasc Endovasc Surg 1996; 12: 207-213
7. Silve Jr MB, Hobson 2nd RW, Pappas PJ, Jamil Z, Araki CT, Goldberg MC etal. A strategy for increasing use of autogenous hemodialysis access procedures: impact of preoperative noninvasive evaluation. J Vasc Surg 1998; 27: 302-307
8. Beathard GA, Arnold P, Jackson J, Litchfield T. Aggressive treatment of early AVF failure. Kidney Int 2003, 64:1487-1494
9. Asif A, Cherla G, Merrill D, Cipleu CD, Briones P, Pennell P: Conversion of tunneled hemodialysis catheter consigned patients to arteriovenous fistula. Kidney Int 67: 2399-2407, 2005
10. Faiyaz R, Abrero K, Zaman F, Pervez A, Zibari G, Work J: Salvage of poorly developed arteriovenous fistula with percutaneous ligation of accessory veins. Am J Kidney Dis 39: 824-827, 2002
11. Lazarides MK, Georgiadis GS, Antoniou GA, Staramos DN. A meta-analysis of dialysis access outcome in elderly patients. J Vasc Surg 2007; 45: 302-7
12. J Parmar, M.Aslam, N.Standfield. Pre-operative radial artery diameter predicts early failure of arteriovenous fistula(AVF) for hemodialysis. Eur J vasc Endovasc Surg 33: 113-115, 2007
13. M.Marko. Native arteriovenous fistula: Preoperative evaluation. Am J Kidney Dis 39: 1218-1225, 2002
14. M.Marko. Non-invasive evaluation for vessels by duplex sonography prior to construction of arteriovenous fistula for haemodialysis. Nephro Dial Transplant 1998; 13: 125-129
15. Brimble KS, Rabbat CG, Schiff D, Ingram AJ. The clinical utility of Doppler ultrasound prior to arterivenous fistula creation. Semin Dial 2001;14(5):314-317.
16. NFK-K/DOQI. Clinical practice guidelines for vascular access: Update 2000. Am J Kidney Dis 2001;31(1):137-181.
17. Miller PE, Tolwani A, Luscy Cp, Deierhoi MH, Pailey R, Redden DT, Allon M. Predictors of adequacy of arterio-venous fistulas in hemodialysis patients . Kidney Int 1999;56:275-280.
18. Won T, Jang JW, Lee S, Han JJ, Park YS, Ahn JH. Effects of intraoperative blood flow on the early patency of radiocephalic fistulas. Ann Vasc Surg 2000;14:468-472.
19. Lauvao LS, Ihnat DM, Goshima KR, Chavez L, Gruessner AC, Mills JL. Vein diameter is the major predictor of fistula maturation. Journal of Vascular Surgery.
20. Lin SL, Huang CH, Chen HS, Hsu WA, Yen CJ, Yen TS. Effects of age and diabetes on blood flow rate and primary outcome of newly created hemodialysis aterivenous fistulas. Am J Nephrol 1998;18:96-100.
21. Weale R, Bevis P, Neary WD, Boyes S, Morgan JD, Lear PA, et al. Radiocephalic and brachiocephalic arteriovenous fistula outcomes in the elderly. J Vasc Surg2008;47:44-150.