

End Stage Renal Disease: AVF for Hemodialysis: Clinical Assessment with/without Ultrasound Doppler, Complications and Failure

Sunil Seth¹, Gurinderjit Singh Nagi², Suruchi Seth³

How to cite this article:

Sunil Seth, Gurinderjit Singh Nagi, Suruchi Seth/End Stage Renal Disease: AVF for Hemodialysis: Clinical Assessment with/without Ultrasound Doppler, Complications and Failure/New Indian J Surg. 2023;14(1):21–25.

Abstract

Objective/Background: The objective of this study was to study the complications and failure rate after creating arteriovenous fistula in patients suffering from end stage renal disease (chronic renal failure). It was also intended to study the importance of preoperative Clinical assessment/physical examination of the patient; and if the vessels for anastomosis appeared to be of doubtful size, then doppler study was done to ensure that vein is of adequate size for creation of a good fistula.

Method: In this study 121 cases of end stage renal disease (chronic renal failure) who needed vascular access for hemodialysis were taken. Ultrasound Doppler study was conducted in those patients whose vessels (for anastomosis) appeared to be of small size on Clinical examination. In the study, the arteriovenous fistulae were created under local anesthesia observing all aseptic precautions.

Results: Most commonly, difficulty encountered during surgery was when the caliber of vein was small i.e. less than 2.5 mm. Arteriovenous fistula was created only when the size of vein was atleast 2.0 mm. When the size of vein was small, then longitudinal incision was given in the vein or Cheatlemanouvre was undertaken to perform anastomosis. In 4 of the 121 cases when radiocephalic fistula was attempted, we had to convert to brachio-cephalic. No major complication was encountered during the surgery or post operatively. Some patients (five) had redness and inflammation. Inflammation and redness subsided with antibiotics and it resulted in satisfactory recovery. The fistulas started well showing good thrill. After 30 days, 106 out of 121 AV fistulas created were functioning very well with a patency rate of 87.6%.

Conclusion: There were no major complication after creating arterio venous fistula. It

Author Affiliation: ¹Professor, Department of Radiology, ²Professor, Department of Surgery, ³Associate Professor, Department of Dental Sciences, PIMS Medical College, Garha Road, Jalandhar 144001, Punjab, India.

Corresponding Author: Suruchi Seth, Associate Professor, Department of Dental Sciences, PIMS Medical College, Garha Road, Jalandhar 144001, Punjab, India.

Email: sunilseth@yahoo.com

Received on 20-12-2022

Accepted on 03-01-2023

is important to do thorough physical examination before surgery so that vessel is assessed. In doubtful cases ultra sound doppler study should be done to know the size and patency of vessel. We should also take relevant history especially of hypertension, diabetes, i/v canulation etc.

Keywords: End stage renal disease; Hemodialysis; AV fistula; Patency; Ultrasound doppler.

INTRODUCTION

Chronic renal failure is characterized with progressive and irreversible diminishing of Glomerular filtration rate.^{1,4} Dialysis is a process which helps to carry out the important functions of kidneys. As such it is a substitute for natural functions of kidney. The population with end stage renal disease (chronic renal failure) is increasing and the number of patients who need dialysis is also increasing 10% of current patients every year.⁵ Vast majority of patients suffering from chronic renal failure undergo hemodialysis.⁶ Though there are many options for RRT (like hemodialysis, peritoneal dialysis, renal transplant and conservative management) but hemodialysis remains the common form of dialytic therapy.⁷ Amongst the existing accesses, arteriovenous fistulas are closest to ideal.⁸ Hemodialysis fistulas are surgically created communication between an artery and a vein in one of the extremity (usually radio-cephalic or brachio-cephalic fistula). The most common method for hemodialysis is through AV fistula and this increases the life standards of the patient.⁹ Radiocephalic autogenous fistulas are the first choice for vascular access¹⁰⁻¹⁴ because further fistulas can be created proximally if needed i.e. brachiocephalic or brachio-basilic fistula and the risk of steal syndrome is reduced.^{11,13,15,16} The direct AV communications are called native AV fistula. For hemodialysis, prosthetics are also used as a mean of communication between artery and vein. Many patients have benefitted from prosthetic grafts when autogenous AVF was not feasible.¹⁷⁻²⁰ Studies indicate that about 30% of hospitalisations are caused by constructions and complications of vascular access.²¹ In 1966, Brescia et al.¹⁰ had first described and used AVF for hemodialysis. A fistula should be placed so that it is suitable for repeated punctures and allow fast blood flow rate for high efficiency dialysis with less complications. An ideal approach really does not exist.^{22,23} Autogenous fistulas have demonstrated higher patency and lower infection rate as well as fewer complications than fistulas created with synthetic material.²⁴

Pre-operative assessment by taking history and Clinical examination is fundamental before vascular access creation.²⁵ This includes age, comorbid conditions, plans like prospect of kidney transplant and in obese patients.²⁵ Apart from history and physical examination, ultrasound doppler is very useful. It is complication free diagnostic method. Studies show that graft placement has decreased and autogenous fistula formation increased.²⁶⁻³¹ So preoperative evaluation with ultrasound doppler

may select suitable vessels and reduce AVF failures.²² Doppler ultrasound allows assessment of arterial circulation based on series of morphological and functional parameters.³² Allen test should be performed before creating vascular access to know the presence and functionality of palmar arches between radial and ulnar arteries.³³⁻³⁶

MATERIAL METHOD

This study was conducted in a total of 121 patients suffering from chronic renal failure (end stage renal disease) during the period 2020-21. All these patients were undergoing hemodialysis for chronic renal failure for more than three months and needed vascular access for regular dialysis. Pre-operative assessment of the patient was done before creation of vascular access. History was taken regarding hypertension, diabetes mellitus. Assessment was also done for peripheral vascular disease, trauma and surgical intervention in the upper extremities, any anticoagulant therapy and history of previous vascular access. Allen test was done to assess the functionality of palmar arches. The patients in the study were having patent palmar arch as tested by Allen test and the minimum diameter of vein included in the study was 2.0mm. Three patients were HCV positive and all universal precautions (including special kits for surgeon and assisting staff) were taken during surgery. Hemoglobin level along with viral markers and RFT were done. On physical examination, if vessels were of small caliber, ultra sound doppler for the upper limb vessels was done in 14 cases. The doppler ultrasound was done with Philips HD 7 ultrasound machine using linear probe having frequency of 7 to 12 Mhz.

The vascular access (arteriovenous fistula) was created either between radial artery and cephalic vein (radiocephalic) near wrist or between brachial artery and cephalic vein (brachiocephalic) at elbow. All the fistulas were created under local anesthesia (using inj. xylocaine 2%) and it was given by local infiltration. First the vein was dissected and after visually confirming its size, the artery was dissected. 5000 international units of heparin was given intravenously and the distal end of vein was ligated. The artery was clamped using two bulldog clamps at a distance of about 1.5 to 2.0 cm. End to side anastomosis was done between vein and artery using 6/0 monofilament prolene for continuous suture. Blood flow was restored by removing the clamps on the artery and vein. The thrill over the fistula was felt to assess the functionality of the

fistula. The wound was closed using interrupted nylon sutures after ensuring that there is no leakage from the anastomosis or the wound site. Patient was advised not to get BP checked from that limb and avoid any injection on the operated limb. Patient was also advised to start exercise after 24 hours. Post-operatively antibiotic was given for seven days and sutures were removed between 10 to 12 days.

RESULTS

The study which consisted of 121 patients (who required vascular access for hemodialysis) was conducted during the period 2020-21. Only two patients were below the age of 20 years while majority of the patients were between the age of 31 and 60 years i.e 96 patients out of 120 were in this age range (Table 1). Males out-numbered the females and the male female ratio was 77.68:22.31 i.e 94 males and 27 females (Table 2). In the study 85 fistulas were created first time while in 36 case the fistula was created for the second or third time after the first fistula stopped functioning over the period of time or the previous fistula failed for some reason. When the vein caliber was small, we had to cut the vein or do cheattlemanouvre so that the anastomosis is adequate. In four cases where we started with creating radiocephalic vascular access was converted to brachiocephalic fistula because of inability to make radiocephalic fistula. In five cases there was redness and inflammation due to infection which subsided with antibiotics. Apart from this, there was no other complication encountered in the study. Post-operatively, the fistulas started very well and the patency after one month was 87.6% with 106 functioning fistulas out of a total of 121.

Table 1: Age wise incidence:

S. No.	Age in years	No. of patients
1	01 to 10	01
2	11 to 20	01
3	21 to 30	08
4	31 to 40	26
5	41 to 50	34
6	51 to 60	36
7	61 to 70	11
8	71 and above	04
9	Total	121

Table 2: Sex ratio

Male patients	94
Female patients	27
Total	121

Table 3: Complications

Inflammation /Redness	5 patients
Pus Formation	0 patient
Paraaesthesia	4 patients

Table 4: Patency rate:

Patency after 1 month	106 out of 121 cases (87.6%)
Patency after 3 months	102 out of 121 cases (84.3%)

DISCUSSION

Hemodialysis through AV fistula remains the most common method of dialysis. Autogenous fistulas have higher patency rate, lower infection rate and fewer complications than fistulas created with synthetic material.²⁴ Amongst the existing accesses for dialysis, arteriovenous fistulas are closest to ideal.⁸

121 cases of end stage renal disease (chronic renal failure) were considered for creation of vascular access. In 85 cases the vascular access (arteriovenous fistula) was created for the first time and in these patients the disease duration was more than two months. In 36 cases fistula was created second or third time after the previous fistula became non functional over a period of time or due to failure. 78 fistulas were created between brachial artery and cephalic vein (brachiocephalic fistula) and 63 were radio cephalic fistulas between radial artery and cephalic vein. In 23 cases, ultra sound doppler study helped to decide in choosing the site of creation of vascular access. Fistula was created only when size of vein was atleast 2.0 mm. It is accepted that a very small caliber vein will fail, but there is no agreed minimum venous diameter to predict radiocephalic AVF maturation.³⁷ Immediate failure on the day of surgery is generally regarded as technical failure of surgery³⁸ but can also be due to inadequate vessel.³⁹ Studies have shown that cephalic vein of 2.0mm or less have higher failure rate and should not be considered.^{22,40-44}

Pre-operative physical examination has been shown to predict success rate in about 70-80%. Doppler ultrasound has increased the number of patients who are suitable for AVF. Preoperative evaluation with ultra sound may help in selecting suitable vessels and reduce AVF failures.²¹ Of course ultrasound examination is more time consuming than physical examination and requires

an experienced examiner and special equipment. Doppler ultrasound is noninvasive, safe and repeatable.⁴⁵ Doppler Ultrasound may not be done routinely but used when anomalies appear on physical examination.⁴⁶ International guidelines, however, recommend its use in all patients who are candidates for AVF along with physical examination.⁴⁷

CONCLUSION

In this study we found that vascular access can be created safely and there are no major complications. The results of the surgery are good. Although physical examination is important for prediction of successful AVF but in selected cases use of ultrasound doppler helps in deciding the site for AVF and whether adequate size vein is available. Patient should be advised regarding post operative precautions like avoiding injection, BP measurement, keeping arm under the body on the operated side. The patient should also be told to start exercise after 24 hours.

REFERENCES

- Schmitz PG. Progressive renal insufficiency: office strategies to prevent or slow progression of kidney disease. *Postgrad Med.* 2000;108(1):145-154.
- National Kidney foundation K/DOQI. Clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. *Am J Kidney Dis.* 2002;39(2 Suppl 1):S217-246.
- Stojimirovic B, Petrovic D. Clinical significance of risk factors control in prevention of chronic renal failure progression. *Vojnosanit Pregl.* 2006;63(6):585-591.
- Petrovic D, Stojimirovic B. Proteinuria as a risk factor for progression of chronic renal disease. *Vojnosanit Pregl.* 2008;65(7):552-558.
- Roijens PP, Burgmans JP, Yo TI, Hop WC, de Smet AA, van den Dorpel MA, et al. Autogenous radial-cephalic or prosthetic brachial-antecubital forearm loop AVF in patients with compromised vessels? A randomized, multicenter study of the patency of primary hemodialysis access. *J Vasc Surg.* 2005;42:481-486.
- Sociedade Brasileira de Nefrologia (SBN). Censo SBN- 2018, Sao Paulo: SBN; 2018. Available from: <https://sbn.org.br/censo-2018>
- Thomas B, Wulf S, Bikov B, Perico N, Cortinovis M, Courville de Vaccaro K, et al. Maintenance dialysis throughout the world in years 1990 and 2010. *J Am Soc Nephrol.* 2015;26:2621-2623.
- Vascular access 2006 Work Group. Clinical practice guidelines for vascular access. *Am J Kidney Dis.* 2006 Jul;48(Suppl1):S176-247.
- Rahman A, Ozsin KK. Upper extremity otogenarteriovenous fistulas for hemodialysis. *Turkish J Vasc Surg.* 2007;16:19-24
- Brescia MJ, Cimmino JE, Appel K, Hurwicz BJ. Chronic hemodialysis using venipuncture and a surgically created arteriovenous fistula. *N Engl J Med.* 1966;275:1089-1092.
- Gilmore J, KDOQI Clinical practice guidelines and Clinical practice recommendations 2006 updates. *Nephrol Nur J.* 2006;33(5):487-488.
- Gibbons CP. Primary vascular access. *Eur J Vasc Endovasc Surg.* 2006; 31(5):523-529.
- Perera GB, Mueller MP, Kubaska SM, Wilson SE, Lawrence PF, Fujitani RM. Superiority of autogenous arteriovenous hemodialysis access: maintenance of function with fewer secondary interventions. *Ann Vasc Surg.* 2004;18(1):66-73.
- Sidawy AN, Spergel LM, Besarab A. The society for vascular surgery: Clinical practice guidelines for the surgical placement and maintenance of arteriovenous hemodialysis access. *J Vasc Surg.* 2008;48(5):22-25.
- NKF-K/DOQI Clinical Practice Guidelines for Vascular Access. Update 2000. *Am J kidney Dis.* 2001;37(1):137-181.
- Vascular access work group. Clinical practice guidelines for vascular access. *Am J Kidney Dis.* 2006;48(1):248-273.
- Biggers JA, Remmers AR, Glassfoed DM, Lindley JD, Sarles HE, Fish JC. Bovine graft fistulas in patients with vascular access problems receiving hemodialysis. *Surg Gynecol Obstet.* 1975;140:690-692.
- Morgan A, Lazarus M: Vascular access for dialysis, Techniques and results with newer methods. *Am J Surg.* 1975;129:432-439.
- Jacob ET, Shapira Z, Boner G. Dacron arteriovenous interposition graft: An access to circulation in patients on chronic hemodialysis. *Angiology.* 1977;28:31-35.
- Baker LD, Johnson JM, Goldfarb D. Expanded polytetrafluoroethylene (PTFE) subcutaneous arteriovenous conduit: a improved vascular access for chronic hemodialysis. *Trans Am Soc Artif Inter Organs.* 1976;22:382-387.
- Metcalfe W, Khan IH, Prescott GJ, Simpson K, Macleod AM. On behalf of the scottish renal registry: hospitalization in the first year of renal replacement therapy for end stage renal disease. *Quarterly J Med.* 2003;96:899-909.
- Allon M, Robbin M. Increasing arteriovenous fistulas in hemodialysis patients: problems and solutions. *Kidney Int.* 2002;62:1109-1124.
- Ethier J, Memdelsohn DC, Elder SJ, Hasegawa

- T, Akizawa T, Akiba T, Canaud BJ, Pisoni RL. Vascular access use and outcomes: an international perspective from the dialysis outcomes and practice patterns study. *Nephrol Dial Transplant*. 2008;23:3219-3226.
24. Murad MH, Elamin MB, Sidawy AN. Autogenous versus prosthetic vascular access for hemodialysis: a systematic review and meta-analysis. *J Vasc Surg*. 2008;48(5):34-47.
25. Ibeas J, Roca-Tey R, Vallespin J, Moreno T, Monux G, Marti-Monros A, et al. Spanish Clinical guidelines on vascular access for hemodialysis. *Nefrologia*. 2017;37: Suppl.1:1-191
26. Guedes MARQUES m, Ibeas J, Botelho C, Maia P, Ponce P. Doppler ultrasound: a powerful tool for vascular access surveillance. *Semin Dial* 2015;28:206-210.
27. Wong CS, McNicholas N, Healy D, Clarke-Moloney M, Coffey JC, Grace PA, et al. A systematic review of preoperative duplex ultrasonography and arteriovenous fistula formation. *J Vasc Surg* 2013;57:1129-1133.
28. Ko SH, Bandyk DF, Hodgkiss-Harlow KD, Barleben A, Lane J 3rd. Estimation of brachial artery volume flow by duplex ultrasound imaging predicts dialysis access maturation. *J Vasc Surg* 2015;61:1521-1527.
29. Lomonte C, Meola M, Petrucci I, Casucci F, Basile C. The key role of color doppler ultrasound in the work-up of hemodialysis vascular access. *Semin Dial* 2015;28:211-215.
30. Matsui S, nakai K, Taniguchi T, Yokomatsu T, Kono Y, et al. Systematic evaluation of vascular access intervention therapy and x-ray exposure time: a single-center observational study. *Ther Apher Dial* 2012;16:169-172
31. Older RA, Gizienki TA, Wilkowski MJ, Angle JF, Cote DA. Hemodialysis access stenosis: early detection with color DUS. *Radiology* 1998;207:161-164.
32. Malovrh M (2002) Native arteriovenous fistula: preoperative evaluation. *Am J Kidney Dis* 39:1218-1225
33. Basarab A, Brouwer D. Aligning Hemodialysis Treatment Practices with the National Kidney Foundation, sK/DOQI Vascular access Guidelines. *Semin Dial*. 2004;33(11):694-711.
34. NKF K/DOQI Clinical practice guidelines for vascular access: Update 2000. *Am J Kidney Dis*. 2001;37(1 Suppl 1):S137-181.
35. Kommer K, Nonnast Daniel B, Ritz E. The arteriovenous Fistula. *J Am Soc Nephrol*. 2003;14(6):1669-1680.
36. Asif A, Merrill D, Pennell P. Vascular Access Education, Planning and percutaneous Interventions by Nephrologists. In: Ronco C, Bredolan A, Levin NW, editors. *Cardiovascular Disorders in Hemodialysis*. Basel: Karger; 2005.p.138-149.
37. Malovrh M. The role of sonography in the planning of arteriovenous fistulas for hemodialysis. *Semin Dial* 2003;16:299-303
38. Miller C, Robbin ML, Allon M. Gender differences in outcomes of arteriovenous fistulas in hemodialysis patients. *Kidney Int* 2003;63:346-352
39. Malovrh M. Noninvasive evaluation of vessels by sonography prior to construction of arteriovenous fistulas for hemodialysis. *Nephrol Dial Transplant* 1998;13:125-129
40. Rooijens PP, Burgmans JP, Yo TI. Autogenous radiocephalic or prosthetic brachial atecubital forearm loop AVF in patients with compromised vessels. A randomized multicenter study of the patency of primary hemodialysis access. *J Vasc Surg*. 2005;42(3):481-487.
41. Lauvaio LS, Ihnat DM, Goshima KR, Chavez L, Giruessner AC, Mills JL. Vein diameter is the major predictor of fistula maturation. *J Vasc Surg*. 2009;49(6):1499-1504.
42. Sidawy AN. Society for vascular surgery. Arteriovenous hemodialysis access: the society for vascular surgery practice guidelines. *J Vasc Surg*. 2008;48(5):1.
43. Silve MB, Hobson RW, Pappas PJ. A strategy for increasing use of autogenous hemodialysis access procedures: impact of preventive noninvasive evaluation. *J Vasc Surg*. 1998;27(2):302-307.
44. Mendes RR, Farber MA, Marston WA, Dinwiddie LC, Keagy BA, Burnham SJ. Prediction of wrist arteriovenous fistula maturation preoperative vein mapping with ultrasonography. *J Vasc Surg*. 2002;36(3):460-463.
45. Ferring M, Henderson J, Wilmink A, Smith S (2008) Vascular ultrasound for the preoperative evaluation prior to arteriovenous fistula formation for hemodialysis: review of the evidence. *Nephrol Dial Transpl* 23:1809-1815.
46. Allon M, Lockhart ME, Lilly RZ, Gallichio MH, Young CJ, Barker J et al (2001) Effect of preoperative sonographic mapping on vascular access outcomes in hemodialysis patients. *Kidney Int* 60:2013-2020.
47. Tordoir J, Canaud B, Haage P, Konner K, Basci A, Fouque D et al (2007) EBPG on vascular access. *Nephrol Dial Transpl* 22 (Suppl 2):ii88-ii117