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Retrospective Study of Autologous Arteriovenous Fistula Creation as Vascular Access for Hemodialysis

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ABSTRACT

Introduction

An autologous arteriovenous fistula (AVF) creation is a common vascular procedure for hemodialysis (HD) patients. This surgical procedure aim is to design a vascular conduct that withstands hemodialysis for a durable period. However, the functional outcome of this procedure varies and depends on patients' various predictors. .

Methods

A retrospective observational study was carried out to evaluate the functional outcome of AVF creation at the cardiothoracic vascular surgery unit of the surgery department of B.P Koirala Institute of Health Sciences from February 2019 to February 2020. The medical file of the patients was studied, relevant data entered and analyzed in SPSS statistical software.

Results

There were a total of 112 autologous AVF created during the study period. The mean age of the patients was 48.66±15.64 years. There were 75(67%) males and 37(33%) females. The most common limb of fistula creation was left non-dominant upper limb 95(84.8%) and right upper limb 17(15.2%). The most common type of AVF was radiocephalic fistula 66(58.9%) and brachiocephalic fistula 46(41.1%). There were 92(82.1%) mature fistula at eight weeks follow-up. These include 54(48.2%) radiocephalic fistulas and 38(33.9%) brachiocephalic fistulas. There were 20(17.8%) delayed matured fistulas at 12 weeks (12 radiocephalic and 8 brachiocephalic AVF).

Conclusions

The creation of an autologous AVF for hemodialysis in the upper limb has fewer complications and the maturation of the AVF depends on the vessel's diameter. Radio-cephalic and Brachiocephalic AVF usually matures between six to eight weeks duration.

Keywords: Arteriovenous Fistula (AVF); Autologous Vascular Access; End Stage Renal Disease (ESKD); Haemodialysis Vascular Shunts.

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INTRODUCTION

Autologous arteriovenous fistula (AVF) creation is a common procedure for hemodialysis patients considered as gold standard vascular access.[2] AVF is the backbone of hemodialysis patients and improves the quality of life as compared to other forms of access.[3,4] The national kidney foundation guidelines recommend assessment and creation of autologous AVF for long-term hemodialysis patients with end-stage kidney disease (ESKD) when eGFR is 15 to 20 mL/1.73 min^2 with progressive poor renal function.[1]

AVF creation, its maturation rate, and long-term patency is influenced by various factors. Size of the vessels, its inflow and outflow rate plays an important role in placement and development of AVF.[5,6] Preoperative clinical examination and duplex ultrasound in selected high-risk patients is important in selecting types and location of AV fistula. It also establishes any abnormalities in the arterial and venous network of upper limb, especially in patients with vascular disease and diabetes where clinical examination alone can be inadequate .[7,8]

A period of six to eight weeks after autologous fistula creation is a frivolous interval where the fistula heals and matures for hemodialysis procedure.[6,7] The ideal fistula access must be a minimum of six millimeter in diameter, have six-millimeter depth from skin and should have blood flow greater than 600 ml/min. [9] After description of autologous AVF procedure by Cimino and Brescia in 1966, there has been lots of modifications and configurations in the procedure with variable outcomes.[7,10]

Radiocephalic and brachiocephalic AVFs are the two most common types of AVFs for hemodialysis.[9,12,13] Aim of the article is to identify some of the important details that determine the maturation of the procedure.

METHODS

This was a single-center, retrospective observational study, conducted by reviewing the medical files of the patients with inclusion criteria as end-stage renal disease (ESKD) and AVF creation, under cardiothoracic vascular surgery unit of B.P Koirala Institute of health sciences from February 2019 to February 2020 . The patients with small size vessels or unfit for the procedure were excluded. The study was conducted after obtaining clearance from the Institutional Review Committee of B.P. Koirala Institute of Health Sciences (IRC/1776/020).

Preoperative Assessment:

All the ESKD patients routinely underwent complete general examination and focused local assessment of veins and artery of the upper limbs from distal to proximal for type and location of AVF creation. A two-minute tourniquet test for venous distensibility, an Allen test for palmar arch patency and tests for central venous occlusion were carried out. Whenever in doubt, vessel mapping for vascular access was performed and vessels marked preoperatively.

Patients having inadequate vessel size (artery diameter <1.5mm and vein diameter <2mm) and the recent prick or injury to the vessels were followed up later. AVF creation was planned after a written consent under adequate local anesthesia using 2% Xylocaine injection and follow- up at one week, and then monthly for three months.

Surgical Techniques

Once the suitable vein and artery was selected in the wrist or elbow, the next important step was to design or create the fistula. Forearm was preferred than arm for AVF site whenever suitable. The radial artery and cephalic vein in the wrist were exposed by a single two to three centimeters transverse incision. The dissection

was confined to the cephalic vein and care taken not to injure the adjacent superficial radial nerve.

The vein was looped and any side branched fixed. The radial artery situated deep to and medial to the brachioradialis tendon was then dissected and proximal and distal control of around 6 to 10- mm long taken. The distal end of the cephalic vein was secured and divided and the appropriate length was brought closer to the artery. After regional heparin and a broad-spectrum antibiotic, the radial artery was clamped and an arteriotomy of five to six millimeters was made.

The end of the vein prepared was then anastomosed to the side of the artery (side to end anastomosis) using a running 7-0 double arm polypropylene suture. The soft clamp was then released in the order of vein clamp or loop, distal, and then proximal arterial clamps. Once the hemostasis was completed, the vein was palpated for a good thrill which confirms good fistula outflow and outcome. The skin was then sutured using 3-0 absorbable subcutaneous sutures and loose dressing was applied.

For patients without radiocephalic AV fistula possibility, brachiocephalic AV fistula was the ideal vascular access. The transverse incision was given from the cephalic vein to the brachial artery at the elbow crease. The cephalic vein was dissected and adequate length to meet the artery was prepared. Sometimes, the median antecubital vein if appropriate was used, leaving the cephalic vein.

Exploration of the brachial artery which was often beneath the flexor retinaculum of the brachioradialis muscle was carried out combining electrocautry and sharp dissection. Major variations of the brachial artery were found and therefore adequate exposure of the artery with proximal and distal control was taken and prepared for arteriotomy after regional heparin and antibiotics. The procedure was completed with a 7-0 double arm polypropylene suture, the technique of anastomosis, hemostasis, and wound closure being similar to radiocephalic AV fistula.

Statistical Analysis

The statistical analysis was performed using SPSS Software 16 (USA). Categorical variables were analyzed as mean values with standard deviation (±SD) and continuous values were shown as frequency (n) and percentages (%).

RESULTS

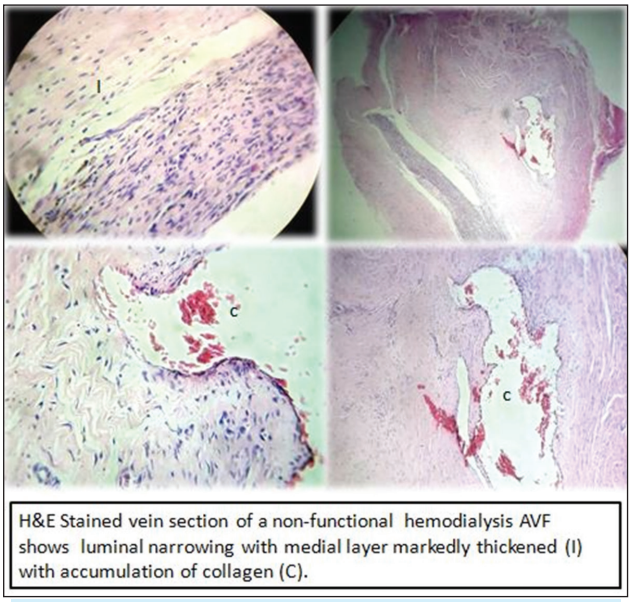
There was a total of 112 autologous AVF created during the study period. The mean age of the patients was 48.66±15.64 years. There were 75(67%) male and 37(33%) female (**Table 1**). The most common limb of AVF creation was left non-dominant upper limb 95(84.80%) and right upper limb 17 (15.20%). The most common type of fistula was radiocephalic fistula 66(58.9%) and brachiocephalic fistula 46(41.1%).

Table 1. Demographic profile of the patients.

S. N	Variables	n (%)
1	Age	48.66 ± 15.642
2	Gender Male Female	 75 (67%) 37 (33%)
3	Limbs Left Upper Limb AVF Right Upper Limb AVF	 95(84.8%) 17(15.2%)
4	Fistula Type Radiocephalic AVF Brachiocephalic AVF	 66 (58.9%) 46 (41.1%)
5	Artery size (mm) 2.0 mm 2.5 mm 3.0 mm	 2 (1.8%) 57 (50.9%) 53 (47.3%)
6	Vein size (mm) 2.5 mm 3.0 mm	 58 (51.8%) 54(48.2%)

7	Causes of ESKD	
	Hypertension	14 (12.5%)
	Diabetes Mellitus	17 (15.2%)
	Chronic Glomerulonephritis	36 (32.1%)
	Hypertension +Diabetes Mellitus	15 (13.4%)
	Other Causes	30 (26.8%)
8	Risk Factors	
	Hypertension	17(15.2%)
	Diabetes Mellitus	23(20.5%)
	Ischemic Heart Disease	18(16.1%)
	Peripheral Vascular Disease	18(16.1%)
	Multiple factors	36(32.1%)
9	Temporary catheter use	52(46.4%)

There were 92(82.1%) mature fistula at eight weeks follow-up (Table 2). These include 54(48.2%) radiocephalic fistula and 38(33.9%) brachiocephalic fistulas. There were 20(17.8%) patients with delayed maturation of AVF at 12 weeks (12 radiocephalic and 8 brachiocephalic fistulas). The most common complication was wound infection in three fistulas (2.70%).



H&E Stained vein section of a non-functional hemodialysis AVF shows luminal narrowing with medial layer markedly thickened (I) with accumulation of collagen (C).

Figure 1. Shows vein section of a non-functional AVF.

DISCUSSION

The mature autologous AVF serves as a lifeline for hemodialysis patients. The national kidney foundation guidelines recommend the early creation of autologous AVF in patients with end-stage renal disease with rapid decrease rate of eGFR approximately >10 mL/min/year.[1] Early creation of autologous AVF in progressive renal failure patients improves in the quality of life and prolongs survival. [3,7]

Majority of the ESKD patients in our community remains on hemodialysis life long, as renal transplantation is not possible in most of the centers of the country. An autologous AVF has much benefit over dialysis catheters or grafts in terms of costs, hospital stay and mortality. [14]

Table 2. Functional outcome (Maturation Rate) at 8 and 12 weeks.

Fistula Types	Maturation of AVF		Total
	8 weeks	12 weeks	
Radiocephalic AVF	54 (48.2%)	12(10.7%)	66(58.9%)
Brachiocephalic AVF	38 (33.9%)	08(7.2%	46(41.1%)
Total	92(82.1%)	20(17.9)	112(100%)

The mean anastomosis artery size was 2.73 ± 0.27mm while the mean vein size was 2.74 ± 0.25mm. The most common cause of the end-stage renal disease was chronic glomerulonephritis 36 (32.1%). The most common risk factor present was diabetes mellitus 23(20.5%) and there were multiple risk factors present in 36(32.1%) patients. There were 52(46.4%) patients with previous temporary hemodialysis catheter.

A period of six to eight weeks after AVF creation is a frivolous interval where the fistula heals and matures for hemodialysis procedure. The fistula undergoes adaptation and remodeling due to increased flow. The ideal autologous fistula must be a minimum of six millimeter in diameter, have six-millimeter depth from the skin and should have blood flow greater than 600 ml/min. [5,6,8]

Hemodialysis initiation without AVF creation has been seen in up to 93% of the patients and has major complications.[11] In our study, 52(46.4%) patients began hemodialysis with central venous catheter. An ipsilateral autologous fistula was constructed in more than 50% of these patients with an internal jugular catheter. However, subclavian catheter and ipsilateral AVF creation was avoided because of the risk of hand swelling and acronecrosis.

The preoperative assessment of the upper limbs is an essential part in selection of the type and location of AVF, combined with duplex ultrasound in selected patients.[15] The vessels were assessed for caliber, distensibility and continuity. The study done by Silva et al. [16] showed that the maturation rate of autologous fistula improved fourfold with the routine noninvasive assessment of the arterial inflow and venous outflow rate.

The size and quality of the vessels possess significant role in the development of the fistula. Our study showed that the mean artery size was 2.73-mm and vein size was 2.74-mm which was small-caliber vessels. The maturation rate in the study was 92 (82.1%) at eight weeks and 20 (17.8%) at 12 weeks. Goh et al.[17] showed that radiocephalic fistula had fewer complications like steal syndrome and maturation rate was only 55% with a vessels of small caliber (<2.5-mm).

There were two (1.7%) fistulas which needed assessment with duplex ultrasound after eight weeks and diversion of venous flow and stenosis was seen in both the fistulas. The diverting venous branch was ligated and the stenotic vein was dilated to maximize flow which improved in fistula function. The fistula tends to mature after correction in few similar patients while in some, more proximal fistula needs to be created.[12]

There seems to be an international difference in the type and location of autologous AVF creation and a shift from lower arm to upper arm AVF is seen in many centers due to better maturation of upper arm AVF (34% vs 59%). [7] The upper arm brachiocephalic AVF has been recommended in diabetic, females and older hemodialysis patients where there is high risk of fistula failure.

Huben et al. [18] demonstrated major complications like steal syndrome and hand ischemia in seven percent of diabetic, females, and peripheral vascular disease patients. Our study didn't show any such complications as the high-risk patients were preoperatively carefully assessed by duplex ultrasound study and surgery was planned to minimize adverse effects. Thamer et al.[19] in the cost analysis study of the procedure found that there was a financial burden when fistula failed to mature on time and revision surgery was needed.

There are complex modifiable and non-modifiable factors that affected the long-term patency of the autologous AVF. [20] Modifiable factors like smoking, obesity, early referral, ultrasound imaging, anastomosis type and flow assessment have been found to affect the patency of fistulas. Non-modifiable factors for AVF patency were increase age, diabetes, hypotension, arterial diameter, arteriosclerosis, venous diameter and venous distensibility. [20–22]

A systematic review done by Tanner et al. [17] on drug treatments to increase the patency of fistula showed that clopidogrel of 75mg/day showed a beneficial effect. However, the random-effect meta-analysis on the use of the drug showed no benefit.[18] There have been several modifications and configurations of the operative technique. All our procedures were done by artery side to vein end anastomosis with a continuous double arm 7-0 polypropylene suture. This technique

has less complication than interrupted suturing. Kanko et al. [24] described the diamond-shaped technique in 67 patients and found an 89% patency rate in six months.

Early failure within four weeks of the procedure is seen in 29% of patients and emphasis has been made on surgical technique improvement.[20,25] The proper skin incision without crossing the arterialized vein, felicitous handling of the vessels, and correct anastomosis angle with minimal shear stress distribution is advised, with high quality instruments and surgical loupes.[9,26]

Fistula with feeble thrill and low outflow has more chances of thrombosis.[11] Heparin and a broad-spectrum antibiotic are routinely used in many centers and ours too as it prevents early thrombosis and infection. Few patients experience hand and finger edema after AVF creation which usually subsides by elevation of the limb.[25–27]

If the swelling progress to the extent of limiting the mobility, central stenosis should be suspected especially in patients with previous central venous catheters and devices (pacemakers).[18] A duplex ultrasound study or venogram should be performed if such symptoms persist, as it can lead to discoloration of the limb. Endovascular treatment has a high success rate and should be the first choice in such symptomatic patients. [20,28]

Severe pain and coldness after AVF creation is usually rare and if present, one should consider steal syndrome, especially in brachiocephalic AVF. [11] When the arteriotomy is more than 6-mm in the brachial artery, steal syndrome can develop with loss of the extremity function. Revision surgery is usually required.[25,29] Distal pulses and saturation in the arms are routinely inspected after the procedure and any curiosity is confirmed by duplex scan immediately.

Severe calcifications of the fistula especially in older patients can cause thrombosis and threaten the long-term patency of the AVF. [30] The study on pre-existing and postoperative intimal hyperplasia found no association in fistula long-term outcome. [31] Siddiqui et al. [26] review on factors affecting AVF maturation recommended more research studies on the basic biology of AVF maturation. Once the fistula is created, flow in the AVF increases and vascular remodeling and vasodilatation takes place in a non-pathological vessel. Wedgewood et al.[32] studied flow rate in the radial artery and showed that flow increased immediately after the creation of the fistula. Endothelial cell has important role in remodeling and the forward blood flow elicitate cytoskeletal remodeling in the vessels. [2]

Although, there has not been much development in the research of autologous AVF stenosis, it is thought that deposition of fibrin and thrombocyte activation initiated delayed stenosis of the access as shown in a histogram of one non-functional radiocephalic fistula (**Figure 1**). Another factor might be the repeated iatrogenic remodeling from the puncture or cannulation of the vessel causing thrombosis of the access. [9]

An autologous radiocephalic and brachiocephalic fistula with end to side anastomosis provide the best long-term access. Occasionally, when the basilic or cephalic veins are not suitable, complex vascular access becomes necessary with brachial vein transposition or translocation of suitable veins. [25,31] An autologous AVF creation needs more experience and a three-dimensional picture of the after the procedure should be in the back of the mind while creating the fistula.[20,34]

CONCLUSIONS

The creation of an autologous AVF for hemodialysis in the upper limb has fewer complications and the maturation of the AVF depends on the vessel's diameter. Radio-cephalic and Brachiocephalic AVF usually matures between six to eight weeks duration.

REFERENCES

1. Lok CE, Huber TS, Lee T, et al. KDOQI Clinical Practice Guideline for Vascular Access: 2019 Update. American Journal of Kidney Diseases 2020; 75: S1-S164.https://doi.org/10.1053/j.ajkd.2019.12.001 PMID:32778223
2. Alencar de Pinho N, Coscas R, Metzger M, et al. Vascular access conversion and patient outcome after hemodialysis initiation with a nonfunctional arteriovenous access: a prospective registry-based study. BMC Nephrology 2017; 18: 1-11.https://doi.org/10.1186/s12882-017-0492-y PMID:28222688
3. Liyanage T, Ninomiya T, Jha V, et al. Worldwide access to treatment for end-stage kidney disease: A systematic review. The Lancet 2015; 385: 1975-1982.https://doi.org/10.1016/S0140-6736(14)61601-9 PMID:25777665
4. Thant KZ, Quah K, Ng TK, et al. Retrospective review of arteriovenous fistula success rate in a multi-ethnic Asian population. Journal of Vascular Access 2016; 17: 131-137.https://doi.org/10.5301/jva.5000495 PMID:26797904
5. Allon M, Imrey PB, Cheung AK, et al. Relationships Between Clinical Processes and Arteriovenous Fistula Cannulation and Maturation: A Multicenter Prospective Cohort Study. American Journal of Kidney Diseases 2018; 71: 677-689. https://doi.org/10.1053/j.ajkd.2017.10.027 PMID:29398178
6. Bashar K, Conlon PJ, Kheirelseid EAH, et al. Arteriovenous fistula in dialysis patients: Factors implicated in early and late AVF maturation failure. Surgeon 2016; 14: 294-300.https://doi.org/10.1016/j.surge.2016.02.001 PMID:26988630
7. Ethier J, Mendelssohn DC, Elder SJ, et al. Vascular access use and outcomes: An international perspective from the dialysis outcomes and practice patterns study. Nephrology Dialysis Transplantation 2008; 23: 3219-3226. https://doi.org/10.1093/ndt/gfn261 PMID:18511606
8. Georgiadis GS, Argyriou C, Kantartzi K, et al. Which is the most powerful adverse factor for autologous access patency between diabetes and high arterial calcification burden? Renal Failure 2018; 40: 455-457.https://doi.org/10.1080/0886022X.2018.1497518 PMID:30278807
9. Lew SQ, Nguyen BN, Ing TS. Hemodialysis vascular access construction in the upper extremity: A review. Journal of Vascular Access 2015; 16: 87-92.https://doi.org/10.5301/jva.5000299 PMID:25198804
10. Brescia MJ, Cimino JE, Appell K, et al. Chronic hemodialysis using venipuncture and a surgically created arteriovenous fistula. 1966. Journal of the American Society of Nephrology : JASN 1999; 10: 193-199. PMID: 9890327
11. Al-Jaishi AA, Liu AR, Lok CE, et al. Complications of the arteriovenous fistula: A systematic review. Journal of the American Society of Nephrology 2017; 28: 1839-1850. https://doi.org/10.1681/ASN.2016040412 PMID:28031406
12. Lauvao LS, Ihnat DM, Goshima KR, et al. Vein diameter is the major predictor of fistula maturation. Journal of Vascular Surgery 2009; 49: 1499-1504. https://doi.org/10.1016/j.jvs.2009.02.018

PMID:19497513

13. Oprea A, Molnar A, Vlăduțiu D, et al. Correlation between preoperative vein and artery diameters and arteriovenous fistula outcome in patients with end-stage renal disease. Medicine and Pharmacy Reports 2018; 91: 399-407. https://doi.org/10.15386/cjmed-1080 PMID:30564015
14. Konner K, Nonnast-Daniel B, Ritz E. The arteriovenous fistula. Journal of the American Society of Nephrology 2003; 14: 1669-1680. https://doi.org/10.1097/01.ASN.0000069219.88168.39 PMID:12761270
15. Huynh TTT, Garza BN, Geer J, et al. The Role of Preoperative Duplex Ultrasound Vessel Mapping in Determining Primary Failure of Pediatric Hemodialysis Arteriovenous Fistula. Journal for Vascular Ultrasound 2019; 43: 63-68. https://doi.org/10.1177/1544316719831508
16. Silva J, Hobson RW, Pappas PJ, et al. A strategy for increasing use of autologous hemodialysis access procedures: Impact of preoperative noninvasive evaluation. Journal of Vascular Surgery 1998; 27: 302-308.https://doi.org/10.1016/S0741-5214(98)70360-X PMID:9510284
17. Goh MA, Ali JM, Iype S, et al. Outcomes of primary arteriovenous fistulas in patients older than 70 years. Journal of Vascular Surgery 2016; 63: 1333-1340. https://doi.org/10.1016/j.jvs.2015.12.044 PMID:27109796
18. Huber TS, Larive B, Imrey PB, et al. Access-related hand ischemia and the Hemodialysis Fistula Maturation Study. In: Journal of Vascular Surgery. Mosby Inc., 2016, pp. 1050-1058.e1. https://doi.org/10.1016/j.jvs.2016.03.449 PMID:27478007
19. Thamer M, Lee TC, Wasse H, et al. Medicare Costs Associated With Arteriovenous Fistulas Among US Hemodialysis Patients. American Journal of Kidney Diseases 2018; 72: 10-18. https://doi.org/10.1053/j.ajkd.2018.01.034 PMID:29602630
20. Smith GE, Gohil R, Chetter IC. Factors affecting the patency of arteriovenous fistulas for dialysis access. Journal of Vascular Surgery 2012; 55: 849-855. https://doi.org/10.1016/j.jvs.2011.07.095 PMID:22070937
21. Kordzadeh A, Askari A, Hoff M, et al. The Impact of Patient Demographics, Anatomy, Comorbidities, and Peri-operative Planning on the Primary Functional Maturation of Autologous Radiocephalic Arteriovenous Fistula. European Journal of Vascular and Endovascular Surgery 2017; 53: 726-732 https://doi.org/10.1016/j.ejvs.2017.01.015 PMID:28389252
22. Tanner NC, Da Silva A. Medical adjuvant treatment to increase patency of arteriovenous fistulae and grafts. Cochrane Database of Systematic Reviews; 2015. Epub ahead of print 16 July 2015. DOI: 10.1002/14651858.CD002786.pub3.https://doi.org/10.1002/14651858.CD002786.pub3 PMID:26184395
23. Dember LM, Beck GJ, Allon M, et al. Effect of Clopidogrel on Early Failure of Arteriovenous Fistulas for Hemodialysis. Jama 2008; 299: 2164. https://doi.org/10.1001/jama.299.18.2164 PMID:18477783
24. Kanko M, Sen C, Yavuz S, et al. Evaluation

of arteriovenous fistulas made with the diamond-shaped anastomosis technique. Medical Science Monitor; 18. Epub ahead of print 2012. DOI: 10.12659/MSM.883337.https://doi.org/10.12659/MSM.883337 PMID:22936197

25. Lee SJ, Park SH, Lee BH, et al. Microsurgical approach for hemodialysis access. Medicine 2019; 98: e14202.https://doi.org/10.1097/MD.0000000000014202 PMID:30681593
26. Siddiqui MA, Ashraff S, Carline T. Maturation of arteriovenous fistula: Analysis of key factors. Kidney Research and Clinical Practice 2017; 36: 318-328.https://doi.org/10.23876/j.krcp.2017.36.4.318 PMID:29285424
27. Quencer KB, Oklu R. Hemodialysis access thrombosis. Cardiovascular Diagnosis and Therapy 2017; 7: S299-S308. https://doi.org/10.21037/cdt.2017.09.08 PMID:29399534
28. Chawla A, DiRaimo R, Panetta TF. Balloon angioplasty to facilitate autologous arteriovenous access maturation: A new paradigm for upgrading small-caliber veins, improved function, and surveillance. Seminars in Vascular Surgery 2011; 24: 82-88.https://doi.org/10.1053/j.semvascsurg.2011.05.010 PMID:21889095
29. Parmar J, Aslam M, Standfield N. Pre-operative Radial Arterial Diameter Predicts Early Failure of Arteriovenous Fistula (AVF) for Haemodialysis. European Journal of Vascular and Endovascular Surgery 2007; 33: 113-115. https://doi.org/10.1016/j.ejvs.2006.09.001 PMID:17030130
30. Jankovic A, Damjanovic T, Djuric Z, et al. Calcification in arteriovenous fistula blood vessels may predict arteriovenous fistula failure: a 5-year follow-up study. International Urology and Nephrology 2017; 49: 881-887.https://doi.org/10.1007/s11255-017-1515-0 PMID:28124305
31. Tabbara M, Duque JC, Martinez L, et al. Pre-existing and Postoperative Intimal Hyperplasia and Arteriovenous Fistula Outcomes. American Journal of Kidney Diseases 2016; 68: 455-464. https://doi.org/10.1053/j.ajkd.2016.02.044 PMID:27012909
32. Wedgwood KR, Wiggins PA, Guillou PJ. A prospective study of end-to-side vs. side-to-side arteriovenous fistulas for haemodialysis. British Journal of Surgery 1984; 71: 640-642. https://doi.org/10.1002/bjs.1800710831 PMID:6743990
33. Woodside KJ, Bell S, Mukhopadhyay P, et al. Arteriovenous Fistula Maturation in Prevalent Hemodialysis Patients in the United States: A National Study. American Journal of Kidney Diseases 2018; 71: 793-801.https://doi.org/10.1053/j.ajkd.2017.11.020 PMID:29429750
34. Kritayakirana K, Narueponjirakul N, Uthaipaisanwong A, et al. The Effect of Artery and Vein Size on Forearm Hemodialysis Arteriovenous Graft Patency. Annals of Vascular Diseases 2019; 12: 21-24.https://doi.org/10.3400/avd.oa.18-00105 PMID:30931052

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