Journal of Cardiovascular Disease Research

ISSN:0975-3583,0976-2833 VOL13,ISSUE 03,2022

Arteriovenous fistulas in ESRD Patients: Outcomes at standard sites in upper limbs

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Abstract

Introduction

Surgically created arteriovenous fistulas are the gold standard for the vascular access for hemodialysis. Radiocephalic fistulas are the first recommended access. Aim of the study was to find the patencies in upper limb fistulas after being successfully created, over a period of two years.

Material & Methods

In this prospective study 212 arteriovenous fistulas were created in the patients of end stage renal disease over a period of two years from September 2017 to August 2019. Patients were clinically evaluated and examined for upper limb vessels. Those with apparently small veins were advised duplex ultrasonography to check the size and confirm the patency of vessels. After the successful creation of arteriovenous fistulas, patients were followed up for 2 years.

Results

212 AVFs were successfully created and operative success rate was 90.2%. Mean age of the patients was 53.3 years. Over a period of 2 years of follow up a total of 41 (19.3%) fistulas failed. 42% of those failures occurred within the first 72 hours of surgery and the remaining 58% failed gradually over 2 years. Radiocephalic fistulas were made in 67.4% of the patient population but failure percentage was 22.4% which was considerably higher compared to the other types of fistulas.

Conclusions

Fistula patency decreases over a period of time mainly because of thrombosis, spasm, atherosclerosis and intimal hyperplasia. This is particularly drastic within the first 72 hours and then gradual. Radiocephalic fistulas, although a preferred method of access for hemodialysis, have greater chances of failures.

Keywords: Hemodialysis, arteriovenous fistulas, access, maturation, thrombosis, spasm, failure.

Introduction

Chronic kidney disease (CKD) is a progressive dysfunction of kidneys and patients may ultimately develop end stage renal disease (ESRD) which requires renal replacement therapy. Most of these patients require hemodialysis and for that a permanent vascular access is needed. This can be achieved by surgically creating arteriovenous fistula (AVF), IV catheter or a prosthetic graft. AVF is the gold standard for vascular access for hemodialysis because of its advantages over other methods which include less chances of infection, less thrombosis, increased durability of access, desired hemodialysis results and minimal maintenance.

ISSN:0975-3583,0976-2833 VOL13,ISSUE 03,2022

Surgically a connection is created between an artery and a vein to augment blood flow for successful hemodialysis. Blood flow volume could increase by as much as 10 times in the anastomosed vein within one month after successful creation of AVF due to decrease in resistance and also increase in venous pressure. This leads to increase in diameter of the vein as much as three folds and also thickening of the venous wall occurs, called arterialization of the vein. Overall this process is called maturation and usually takes about 4 to 8 weeks. Sometimes the maturation can take as much as 6 months. Non dominant arm is preferred for creation of AVF. AVFs are usually made in the upper limbs but if access is not available then lower limbs could be used. Examination involves inspection and palpation of the cephalic and basilic veins in arm, palpation of radial and brachial arteries, measurement of blood pressure, and Allen's test is performed to evaluate the patency of the palmar arch [1]. Upper limb vascular characteristics of patients are important to determine successful creation and long term patency of AVFs. Preoperative mapping of vessels is done by color doppler ultrasonography. It's a non-invasive procedure used to find out the optimal location for the creation of AVF. The Kidney Disease Outcomes Quality Initiative (KDOQI) guidelines suggest having a vein diameter of 2.0 mm to 2.5 mm, an access segment of 6 cm for cannulation, and patent central and draining veins for successful AVF creation[1][2]. Generally speaking arterial diameter ≥1.6mm and venous diameter≥ 2.5 mm is required for successful creation of AVF. Also ideally it should be around 0.5 cm deep and should have at least 6 to 10 cm segment for successful cannulation. The Society of Vascular Surgery recommends creation of access in the distal arm so as to preserve future central access, also preference is given to the non-dominant upper limb [3]. For adequate hemodialysis blood flow through the AVF should be around 500 ml/min and the vein should acquire a diameter of at least 4 mm [4]. AVF failure usually occurs because of vein related causes like vein diameter less than 1.5 mm, thrombosis, thrombophlebitis, fibrosis and presence of accessory veins. Artery related causes could be artery diameter less than 1.5 mm, hypotension, spasm, stenosis, atherosclerosis. Chances of failure is more in old age, low blood pressure, comorbidities and technical issues. Some failed fistulas can be salvaged by percutaneous interventions. There is a significant drop of blood pressure in patients of ESRD after the successful creation of AVF [5]. Also AVF creation has shown to slow estimated glomerular filtration rate decline [6]. Arterialization and maturation of the vein is important prior to use of hemodialysis [7].

Radiocephalic fistula (RCF) is the first recommended access because of convenience of the site but the disadvantage is higher failure rates due to small diameter of radial artery and cephalic vein [8]. Brachiocephalic (BCF) and brachiobasilic (BBF) are other commonly recommended fistulas. These fistulas may fail because of known and some unknown reasons and one year patency ranges from 60 to 65% [9, 10]. Creation of AVF causes increase in preload because of increase in venous return and decrease in afterload due to decrease in peripheral vascular resistance. Aim of the study was to find the patencies in upper limb fistulas after being successfully created, over a period of two years.

Material & Methods

This prospective study was carried out in the Department of General Surgery & Allied Specialities, GMC Baramulla. 235 ESRD patients were operated upon and 212 successful AVFs were created over a period of two years from September 2017 to August 2019. Patients were generally recommended for AVF creation by a nephrologist and sent to our department when their glomerular filtration rate was ≤ 15 ml/min. Evaluation was done in terms of history taking and examination. This was followed by examination of arteries and veins in upper limbs. Those patients who had upper limb veins apparently small, barely visible and/ or

ISSN:0975-3583,0976-2833 VOL13,ISSUE 03,2022

palpable even after tourniquet application in the proximal arm for 10 minutes were sent for color doppler imaging. Patients with upper limb varicose veins, thrombophlebitis, thrombosis and fibrotic changes of veins were excluded from study. On imaging veins having a diameter of greater than 1.5 mm and normally compressible were selected and the patients with significant atherosclerosis in upper limb arteries were excluded from the study. History of hypertension, diabetes, pneumonia, heart diseases, previous history of dialysis, previous AVF creation and failure was taken into account. Allen test was performed in all patients. After the proper evaluation patients were prepared for the procedure and were asked to avoid upper limb IV injections for at least 3 weeks prior to the procedure. End to side anastomosis that's distal end of the vein and side of the artery, was done in all cases. In all cases of BBFs, basilic vein transposition procedure was performed. Patients were admitted on the day of surgery and the procedure was done under local anaesthesia using 2% Xylocaine. RCFs were preferred over other types and were generally made proximal to the wrist joint in the non-dominant upper limb. Small incision was made in the skin over the artery followed by mobilisation of artery and adjacent vein. 5000 IU of heparin sodium was injected intravenously. Veins were adequately dilated particularly in cases where vein diameter was small. 5 mins after the heparin sodium injection artery was encircled and tightened with vascular slings proximally and distally. A longitudinal incision of about 1 cm was made in radial artery for RCFs while a 5 to 6 mm incision was generally made in brachial artery for BCF and BBFs. Anastomosis between artery and vein was made using 6-0 prolene running sutures. Skin was closed and on table thrill and/ or bruit detected for successful creation of access. Non compressive dressing was applied. Average time for AVF creation was about 1 hour. Patients were advised to take Tab Ecosprin 75 mg daily for 5 days. Patients were encouraged to do hand ball exercises with a soft ball and were advised to keep their limbs elevated to reduce postoperative swelling and pain in the arm. Also patients were advised to avoid intravenous injections in the limb with AVF and avoid pressure over the vessels. Blood pressure measurements in the operated upper limb were to be avoided. Patients were usually discharged on the same day after the procedure was over. Follow up was done in the OPD and dialysis unit for 2 years. Usually it took 1 to 3 months for fistulas to mature and maturation was determined by a nephrologist. By the end of 2 years 47 patients were lost to follow up. Failure of fistula was determined on the basis of absence of thrill and/ or bruit. In case of doubt color doppler ultrasonography was done. Data was analysed and results were tabulated. Microsoft Excel and SPSS 21 were used for data analysis.

Results

212 AVFs were successfully created out of the total 235 ESRD patients which were operated on. 118 (55.6%) were male and 94 (44.3%) were female patients. Female to male ratio was 1.25:1. Mean age of the patients was 53.3 years. Success rate was 90.2% and on-table successful creation of the fistula was determined on the basis of thrill and/ or bruit.

It was found that 75% of the patients were above 40 years old. Pediatric age group i.e. ≤ 18 years comprised 4% of the patient population. No ESRD patients belonged to the age group of 0 to 9 years. Among all the age groups most patients were in the age groups of 50 to 59 years and 60 to 69 years and numbered 43 and 46 patients respectively. Over a period of 2 years of follow up a total of 41 (19.3%) fistulas failed. Also it was seen that many fistula failures occurred just within 72 hours of surgery and constituted 42% of all access failures. After this early period there was a steady decline in fistula failures. Table 1 depicts gradual decline in patency of AVFs as percentages in all age groups. The interesting point to note is that within the 1st 72 hours of creation of AVFs fistula patencies decrease by almost 9%

ISSN:0975-3583,0976-2833 VOL13,ISSUE 03,2022

followed by gradual decline in patency. This decline was more drastic in elderly age groups as shown in Table 2

Table: 1

Age (Years)	Number of Patients	72 hrs	1 Month	6 Months	1 Year	2 Years
10 to 89	212	91.5%	87.7%	84.4%	82.1%	80.7%

Table: 2

Age (Years)	Number of Patients	Patency (%) Within 72 hours
10 to 19	9	88.9%
20 to 29	17	94.1%
30 to 39	27	92.6%
40 to 49	35	91.4%
50 to 59	43	95.3%
60 to 69	46	91.3%
70 to 79	25	88.0%
80 to 89	10	80.0%

RCFs were made in the majority of patients i.e. 67.4% of ESRD patient population since it is a preferred method of creating an access for hemodialysis. 22.4% successfully created RCFs fistulas failed over a period of 2 years. Similarly 10.3% and 27.2% of BCFs and BBFs failed over a period of 2 years. It was found that radiocephalic fistulas had the greater propensity to fail compared to other types of fistulas likely because of the small size of radial artery and cephalic vein in the forearm in comparison to the large size of brachial artery, cephalic vein and basilic vein at cubital fossa. Table 3 shows patencies in different access types over a period of 2 years. BCFs had better patencies at different stages as compared to RCFs and BBFs.

Table: 3

Type of Fistula	Number	72 hrs	1 Month	6 Months	1 Year	2 Years
Radiocephalic	143	(90.1%)	(87.4%)	(83.2%)	(79.7%)	(77.6%)

ISSN:0975-3583,0976-2833 VOL13,ISSUE 03,2022

Brachiocephalic	58	(93.1%)	(91.4%)	(89.7%)	(89.7%)	(89.7%)
Brachiobasilic	11	(90.9%)	(72.7%)	(72.7%)	(72.7%)	(72.7%)

Discussion

After successfully creating AVFs thrombosis and neointimal hyperplasia have been known as main causes of failure of AVFs. Drugs like Aspirin and Clopidogrel are generally ineffective in circumventing neo intimal hyperplasia leading to venous occlusion [11,12]. 42% of the total access failures calculated over the 2 years of study period occurred within the first 72 hours of AVFs creation. This higher percentage of fistula failures is usually because of the small vessel size, initial arterial spasm and thrombosis. when compared to 72 hours occlusion rate in a study conducted by Roy-Chaudhury et al. [10] it was 8%, one year occlusion 18% and 2 years 20%. One year patency ranged from 60 to 65% in a study conducted by Hemachandar [13]. Primary failure occurred in 25% of patients and was more common in elderly, diabetic and in RCFs. In distal fistulas the patency was 74.1%, 64.2%, 49.8%, 33.7%, and 4.1% after 1, 2, 3, 4, and 5 years, respectively, in the patients where upper-arm fistulas were created, these rates were 84.0%, 72.2%, 53.3%, 39.8%, and 12.3% [14]. More failure rate in upper distal fistulas is because of small size of artery and vein which increases the chances of thrombosis and decreases the chances of maturation of fistulas. Of the total 235 cases ESRD which were operated on in our study, 212 fistulas i.e. (90%) were successfully created while compared to a study by Sharma et al. [15] of 70 cases of AVFs, 53 (75.71%) successful cases and 17 (24.2%) were failures Sahasrabuddhe et al [16] performed a study of 271 cases of AVFs, there were 196 (72.3%) successful cases and 75 (27.7%) failures. Basilic vein was used in 77 (28.4%) cases, cephalic vein in 186 (68.6%), and antecubital vein in 8 (3%) cases. End (vein) to side (artery) anastomosis was done in 170 (63%) cases. Side to side anastomosis was done in 100 (37%) cases. On table bruit was present in 244 (90%) and thrill in 232 (85.6%) cases. Primary patency and primary AVFs' failure ranged from 60-70% and 20-26%, respectively. AVFs reduce morbidity and mortality in CKD [17].

Conclusion

Creation of arteriovenous fistulas in the patients of ESRDs is the best method of creating an access for hemodialysis. Hemodialysis at regular intervals is known to decrease the morbidity and prolong the life in such patients. Fistula patency decreases over a period of time mainly because of thrombosis, spasm, atherosclerosis and intimal hyperplasia. This is particularly drastic within the first 72 hours and then gradual. Radiocephalic fistulas, although a preferred method of access for hemodialysis, have greater chances of failure particularly within the early period after creation mainly because of small vessel sizes, spasm and thrombosis. Intimal hyperplasia is the main culprit for fistula failures in the long run.

Acknowledgements

Nil

Funding source

The authors report no involvement in the research by a sponsor that could have influenced the outcome of this work.

ISSN:0975-3583,0976-2833 VOL13,ISSUE 03,2022

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