Original Article

Comparison of distal radiocephalic fistula vs proximal radiocephalic fistula

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Abstract

Background: Distal radiocephalic fistula (DRCF) at wrist is the first option of vascular access in patients undergoing hemodialysis. In patients with a failed DRCF or unsuitable for DRCF the current recommendation is to perform a brachiocephalic fistula. Proximal forearm radiocephalic fistulas (PRCF) are created less frequently. The aim of the present study was to evaluate the outcomes of PRCF and DRCF. **Material and Methods:** A longitudinal study was conducted in the department of MKCG Medical College from January 2018 to July 2019. Data was collected and entered in Microsoft excel. The analysis was done by R version 3.6.1. Quantitative data were presented in the form of Mean and SD and were tested by unpaired *t*-test. Categorical data were presented as count and proportion and was tested by Chi-square test or if applicable Fischer's exact test. Comparison between two procedures was done by Kaplan-Meier method and evaluated by the log-rank test. With the 95% of Level of significance, *P* value <0.05 was consider statistically significant during analysis. **Results:** The demographic data of the two patient groups were similar except that those with PRCF were more likely to have had a previous access and caliber of distal vessel was less. Early failure was lower for PRCF than DRCF (6.06% vs 15%). Primary patency rate at one year was 87.87% in PRCF vs 70% in DRCF. **Conclusion:** A PRCF can be a suitable alternative to a brachiocephalic fistula in patients who cannot receive a DRCF.

Keywords: Arteriovenous fistula, distal fistula, hemodialysis, proximal fistula

Introduction

There are three options available for vascular access in hemodialysis patients e.g., AV graft, AV catheter and arteriovenous fistula (AVF). Among the three arteriovenous fistulas is the preferred method of vascular access for hemodialysis.[1,2] When compared with AV grafts and central catheter, AVF fistula after maturation are associated with lowest complication rate, lower infection, has better long-term survival and lesser intervention are required to maintain long term patency once successfully cannulated for dialysis.[2] Primary failure of AV fistula can be as high as 47% to 60%.[3] Al –Jadish *et al.* in a Meta analysis of 43 studies has reported primary failure to be 40%.[4]

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Current recommendation[5-7] is to create radiocephalic fistula first followed by brachiocephalic fistula and then brachiobasilic fistula. Distal radiocephalic fistulas (DRCF) placed at the wrist has higher non-maturation rate than brachiocephalic fistulas placed in the upper arm.[8] Poor maturation rate are found with female patient, elderly patient, obese patient. Controversy exists regarding the role of diabetes on non-maturation of fistula.[9] When preoperative imaging indicates radial artery size is less than 2 mm, flow rate in radial artery at wrist is less than 40 ml/s, radial artery is calcified, cephalic vein diameter at wrist is less than 2.5 mm chances of failure of maturation is very high.[10] When distal RCF failure to mature or vein is thrombosed and not suitable for DRCF current recommendation is to perform brachiocephalic fistula above elbow.[1]

Brachiocephalic fistula is more prone for steal syndrome, high output cardiac failure, and hand edema. An alternative option is to create a proximal radiocephalic arteriovenous fistula (PRCF)

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between the proximal radial artery and the cephalic vein. Toledo-pereyra *et al.*[11] created proximal forearm fistula by anatomizing proximal radial artery and cephalic vein where as Gracz[12] created PRCF by anastomosis of proximal radial artery to perforating branch of median cubital or cephalic vein end to side fashion. Bonforte *et al.* in 2004[13] created PRCF by anastmosis of radial artery to cephalic vein, median antebrachial vein, perforating vein. Kumar *et al.*[14] created proximal RCF by anastmosis of radial artery with median cubital vein or cephalic vein. Creating an AV fistula at proximal forearm with radial artery preserves future use of brachial artery at upper arm for brachiocephalic fistula (BCF). Jennings *et al.* in 2006 had reported 91% primary patency rate of PRCF which was higher than DRCF.[15] The aim of the present is to compare the outcomes of PRCF and DRCF at a single tertiary care center.

Since proximal radial artery is a suitable alternative for av fistula creation general physician should also preserve the proximal vein and avoid vene puncture or drug administration at this site. Counselling the duty nurses can also preserve this veins for future utilization.

When primary care physicians come across a chronic kidney disease patient they should council the patients regarding the probable site of av fistula creation, which simplifies the work of the surgeons as far as counselling is concerned. Patients with chronic kidney disease often needs vene puncture for blood withdrawal and drug administration. The basic information gained by physicians help in protecting the veins in the forearm so that av fistula can be created. Many patients come with prior vene puncture so that av fistula is difficult to be performed.

We have done a longitudinal study in 53 patients who had undergone AVF fistula. Primary failure, early failure, patency at the end of one year of both the groups was compared.

Material and Methods

Institutional ethical committee clearance was taken. The date of approval is 23.10.2017. From the institutional ethical committee M.K. C.G medical college. Berhampur.

Patient population

All patients who underwent hemodialysis in the medical college were included in the study. All the patients underwent pre-operative Doppler ultrasound to determine size of radial artery, size of cephalic vein, and flow rate at wrist and elbow to determine the feasibility of distal fistula or proximal fistula.

Pre-operative advice

All patients were advised to preserve cephalic vein on the forearm by avoiding any venae puncture prior to fistula creation. Vein diameter was determined after tourniquet application.[16]

Inclusion criteria for DRCF

Radial artery >2 mm at wrist, flow rate >40 ml/sec, cephalic vein >2.5 mm, absence of thrombosis in the cephalic vein.

Inclusion criteria for PRCF

Radial artery <2 mm at wrist, flow rate <40 ml/sec, cephalic vein <2.5 mm, thrombosed cephalic vein, previously failed avf (arterio venous fistula) at wrist.

Operative procedure

All surgeries were done by local infiltration anesthesia using 2% lignocaine with adrenaline. A 4 to 5 cm longitudinal incision was made two fingers below the cubital fossa in the interval between brachioradialis and flexor carpi radialis. Brachial artery, ulnar artery and radial artery were identified [Figure 1]. Radial artery was identified and brought upwards. Cephalic vein or median antebrachial vein were identified [Figure 2]. If median antebrachial vein were present they were preferred. Patency of the vein was confirmed by flushing of heparin solution. If there was free flow of heparinised solution end to side anastomosis was planned. Two bulldog clamp were applied one proximally and one distally. Arteriotomy was done. Microvascular clamp was applied on the vein [Figure 3]. End to side anastomosis was done by back wall first technique. First posterior wall was sutured continuously with prolene 7-0 suture followed by continuous suturing of the anterior wall. After anastomosis is completed papaverine or 2% Loxicard is applied and blood flow was allowed for 15 to 20 minutes. Any leak from the anastomosis was identified [Figure 4]. Patency of fistula is confirmed by palpable thrill. Skin was closed with interrupted 3 -0 polyamide.

Similarly, distally radial artery and cephalic vein were identified and end to side anastomosis was performed as and when required.

Post operatively Doppler ultrasound was done in patients in whom clinical features of fistula maturation were not

Figure 1: Exposure of brachial, radial and ulnar artery. Radial artery is lifted with an instrument

present. Fistulas were considered sonographically mature if post operative vein diameter is at least 0.6 cm, access blood flow 600 ml, located less than 0.6 cm below the skin surface [1]. Fistulas were usually cannulated 6 to 8 wk following their maturation.

Data analysis

A longitudinal study was conducted in the department of MKCG Medical College from January 2018 to July 2019. Data was collected and entered in Microsoft excel. The analysis was done by R version 3.6.1.

Quantitative data were presented in the form of Mean and SD and were tested by unpaired *t*-test. Categorical data were presented as count and proportion and was tested by Chi-square test or if applicable Fischer's exact test. Comparison between two procedures was done by Kaplan-Meier method and evaluated by the log-rank test. With the 95% of Level of significance, *P* value < 0.05 was consider statistically significant during analysis.

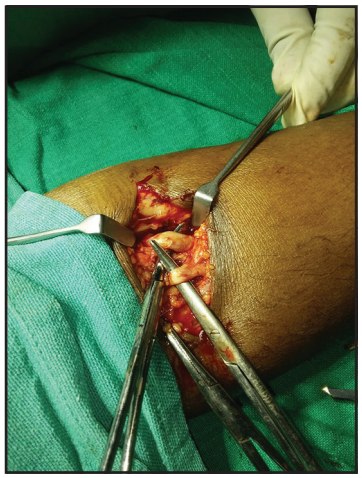


Figure 2: Identification of Cephalic vein or median antebrachial vein

Figure 4: Identification of Any leak from the anastomosis

The access was considered to be clinically mature if it could be cannulated reproducibly for dialysis with two needles with a blood flow ≥ 300 ml/min for at least 1 month within 6 months of its creation. In patients who had not yet initiated dialysis, fistula maturity was assessed during the first month after starting dialysis.

Early failure of fistula is due to thrombosis or failure to mature.[10] Beyond this point fistula failure is unusual. Primary patency is defined as interval from the time of access placement until any intervention designed to maintain or re –establish patency, first occurrence to access thrombosis.[17]

Results

Proximal radiocephalic group

Mean age of the patients was 54 year ranging from 36 to 65 year. Male to female ratio was 3.12: 1. 18 patients (54.54%) were diabetic, 30 (90.09%) were hypertensive, 8 patients (24.24%) had cardiovascular disease. Early failure was 2 (6.06%) cases. Both cases were due to thrombosis. Late failure was seen in 2 patients due to pseudo aneurysm. One patient of pseudo aneurysm was infected and ruptured which was managed by ligation of

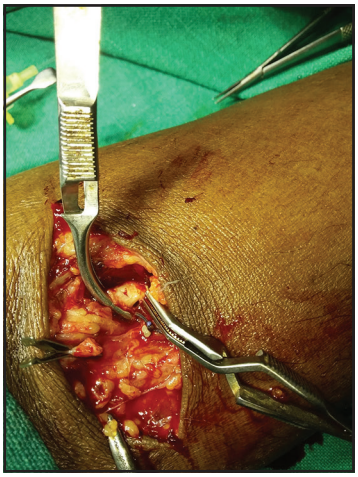


Figure 3: Applying Microvascular clamp on the vein

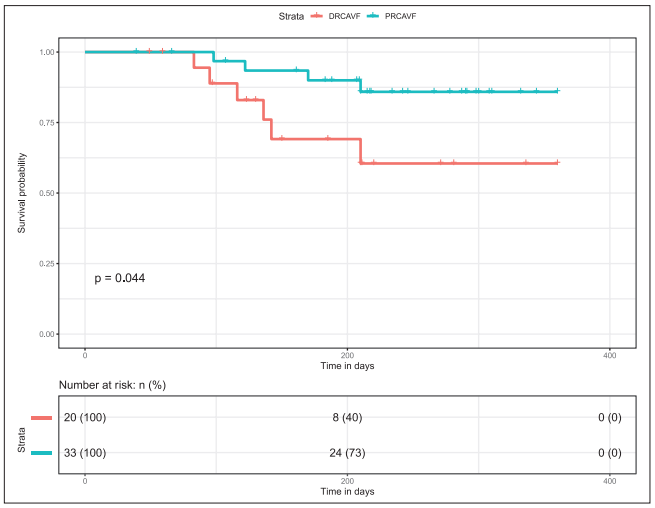
Figure 5: Managing pseudo aneurysm which was infected and ruptured by ligation of fistula

fistula [Figure 5]. Four patients were lost during follow up. No patient had developed steal syndrome. Four patients had mild edema which was managed by hand elevation. Apart from that there was no case of wound infection, wound dehiscence. Out of the 33 cases of PRCF 29 cases were patent at the end of one year.

Distal radiocephalic group

Mean age of the patients was 45.7 year ranging from 33 year to 59 year. Male to female ratio was 3:1. 14 patients (70%) were diabetic, 18 patients (90%) hypertensive 11 (55%) had cardiovascular disease. Early failure was seen in 3 cases. Two cases were due to thrombosis and one case was due to low flow in the fistula. Late failure was seen in two cases due to psuedoaneyrysm formation. Four patients were lost during follow up. No patient had developed steal syndrome. 2 patients had mild edema which were managed by hand elevation. One patient had hematoma at the operated site.

Demographic data between the two groups were similar in terms of age and sex [Table 1]. Early failure was significantly lower in patients with PRCF (6.06%) as compared to those with DRCF (9.09%). Patency rate at the end of one year in PRCF group was higher than DRCF group (87.87% vs 70%). Difference in patency rate was statistically significant [Graph 1].



Graph 1: Kaplan Meier curve of survival analysis between two procedures. Log-rank test shows there is significant difference between median patency between two procedures ($P < 0.05$)

Table 1: Demographic comparison between two group

Characteristics	PRCV	DRCV
Age (yr.) (Mean)	54	45.7 y
Sex		
Male	25 (75.76%)	15 (75.0%)
Female	8 (24.24%)	5 (25.0%)
DM		
Yes	18 (54.54%)	14 (70.0%)
No	15 (45.45%)	6 (30.0%)
Hypertension		
Yes	30 (90.09%)	33 (100%)

Discussion

Ever since Bressica *et al.*[18] has described side to side distal RCF in 1966 it has become procedure of choice for hemodialysis access. Ideal AVF should provide adequate flow without any long-term complication. When distal RCF has failed, veins are not adequate caliber, artery is not of adequate caliber, artery is calcified, radial artery flow at wrist <40 ml/min, and patient is obese brachiocephalic fistula has been described as second option.[1] Although Brachiocephalic fistula is recommended as second option, it is associated with steal syndrome, high output failure, left ventricular disorder, volume overload,[19] right ventricular failure.[20] Tordoir *et al.*[21] reported symptomatic ischemia 10-20% cases BCF and brachiobasilic fistula, 4.3- 6% of forearm prosthetic AVF, 1-1.8% of radiocephalic AVF. Incidence of dialysis associated steal syndrome is extremely rare following proximal RCF.[20] Burns and Jennings in 2003[22] found Proximal forearm fistula to be safe and reliable with no incidence of steal after 42 months. Studies have reported low incidence of steal syndrome (0- 3%) for PRCF group compared with higher (20%) in BCF. In our study there was no case of steal syndrome in either PRCF group or DRCF group**.** When radial artery is used as inflow artery ulnar artery is still available for vascular supply and prevents steal syndrome. The vascular steal phenomenon following brachiocephalic fistula necessitates closure of the fistula. If it occurs in cases of radiocephalic fistula, it can simply be treated by ligating the radial artery distal to the anastomosis. Primary avf failure was 20% for proximal AVF and 28% for distal AVF.[4] Our results are better than the previous study by Al - Jaishi *et al.* Lower primary failure can be an attributed to larger diameter of the proximal artery than distal radial artery. Large diameter of vessel favors higher flow and lower failure.[8,23]

In our series thrombosis and failure of maturation are cause of early failure (6.06%). Kumar *et al.* reported early failure rate in 16 (5%) patients whereas eight (2.5%) fistulas failed at a later date.[14] Rate of thrombosis in our series was seen in 6.06% cases in PRCF group and 15% case in DRCF group. Early cause of thrombosis is mostly technical. It was decreased in our series by use of finer suture material (7-0 for PRCF, 8-0 for DRCF), use of magnification loupe, pre operative screening of healthy vein, and use of clopidogrel in the post operative period. Prevention of early thrombosis maintains flow across the fistula site and favours maturation. Late cause of thrombosis occurs due to intimal hyperplasia. Thrombosis can be managed by thrombectomy. But in our series all cases presented late with sign of thrombophlebitis. So thrombectomy was not tried in any of the cases. After initiation of hemodialysis by fistula repeated needle insertion can lead to pseudo aneurysm formation[24] which can get infected and rupture. In our series pseudo aneurysm occurred in (2/33 cases 6.06%) in PRF and in (2/20 cases 10%) in DRCF group. Out of total four cases of pseudo aneurysm one case had infected and

ruptured. It was managed by ligation of the fistula [Figure 5]. Pseudo aneurysm can also be due higher blood flow. Higher blood flow increase the pseudo aneurysm risk by 25%.[24] Since proximal radial artery has less flow than brachial artery it has theoretical chance of low pseudo aneurysm than BCF. Pseudo aneurysm at the fistula site required elective resection of the pseudo aneurysm with repair of the artery or it can be ligated. In our study 6.06% of PRCF developed anastomotic pseudo aneurysm. This was higher than 2.24% incidence reported by Zibal *et al.*[25] Elseviers and van[26] Padberg.[27] It was lower than 8.3% incidence reported by Eldesouky *et al.*[28] Higher incidence of pseudo aneurysm may be due to infection in our environment and inadequate sterilization.

Primary patency rate was higher in PRCF group (87.87%) than 70% for DRCF group. Meta analysis by Wu *et al.*[18] reported patency rate of PRCF ranges from 47% to 92%. In our series it was 87.87% for PRCF which was comparable to previous studies. Both transverse incision[14] and longitudinal incision has been described for proximal AVF. Transverse incision prevents adequate exposure of brachial, radial, ulnar artery. Transverse incision cause more disruption of lymphatic vessels.[29] We have used longitudinal incision in all cases. Healing at the incision site was excellent in our series with no case of wound dehiscence.

Side to side anastomosis and end to side anastomosis has been described for arteriovenous fistula. Systematic review and meta analysis between these two methods have found end to side anastomosis to have similar maturation rate and patency rate as side to side anastomosis with less risk of steal syndrome in end to side group.[30] Side to side anastomosis has greatest risk of venous hypertension.[31] End to side (end of vein to side of artery) has highest proximal venous flow and a relatively low risk of venous hypertension.[31] We have used end to side anastomosis in all cases.

There were two case of hand edema for proximal fistula which was managed conservatively. Carpal tunnel syndrome and median nerve compression are also well-recognized complications of brachiocephalic AVF, most cases being secondary to vascular steal syndrome. No such complication occurred in PRCF or DRCF group.

Our result of PRCF vs DRCF favors PRCF which is similar to result by Bhalodia *et al.* in 2011.[32] Our study differs from the previous study in the manner of vascular anastomosis. They have done side to side anastomosis while in our study we have done end to side anastomosis**.** Previous guideline has suggested BCF as second option to DRCF.[5-7] Recent studies by Arnaoutakis *et al.*[33] and Eldesouky *et al.*[28] has favored proximal radiocephalic fistula over brachiocephalic fistula. Although higher caliber of brachial artery has resulted in higher flow rate at 6 week, it is associated with more complications of arm swelling, steal syndrome, pseudo aneurysm. Patency rate at one year was nearly similar in both cases. (66% for BCF vs 63% for PRCF). Brachiocephalic fistula sacrifices potential access sites in the forearm. Proximal RCF has higher patency rate than DRCF, lesser complication than brachiocephalic fistula, and long-term patency rate is similar to brachiocephalic fistula. Use of radial artery preserves brachial artery for future brachiocephalic fistula.

So, we recommend the following for achieving good results in av fistula surgery

1. Use of proximal radial artery when distal artery is not suitable for surgery.
2. Use of longituditional incision.
3. Use of end to side anastomosis.
4. Use of microsurgical loupe.
5. Use of finer suture material 6-0 for proximal anastomosis and 8 -0 for distal anastomosis.

Conclusion

With substantially lower primary failure rate, higher patency rate and lower complication proximal radiocephalic fistulas (PRCF) is an attractive alternative to brachiocephalic fistulas in failed DRCF and patients who cannot receive a distal radiocephalic fistula (DRCF).

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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