Comparative study between brachiocephalic fistula and proximal radiocephalic fistula for hemodialysis in patients with end-stage renal disease

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Objectives
To evaluate the proximal radiocephalic arteriovenous fistula (AVF) versus brachiocephalic fistula for hemodialysis in terms of patency and complications.
Background
The distal radiocephalic fistula at wrist is the gold standard AVF for hemodialysis as it reduces the incidence of steal syndrome but with high failure rate. If distal vessels are not suitable or exhausted, elbow fistula is a good vascular access but with increased incidence of steal syndrome, so doing proximal radiocephalic AVF is a good alternative option.
Patients and methods
A prospective randomized study including 60 patients in need for hemodialysis access was done between January 2016 and January 2017 and was followed up to July 2017 at Menoufia University Hospital. The patients were randomly categorized into two groups including 30 patients in each group. Primary success rate, primary patency, secondary patency rates, and complications of each group were collected and analyzed.
Results
In the proximal radiocephalic group, primary fistula failure was 0%, while six (20%) fistulas failed later, four of them due to thrombosis, one due to anastomotic aneurysm and the other due to severe venous hypertension. No patients developed steal syndrome, whereas in the brachiocephalic group, primary fistula failure was also 0% and six (20%) fistulas failed later on, three of them due to thrombosis, one due to anastomotic aneurysm, one due to venous hypertension, and the last one due to steal syndrome. Primary patency rates for both proximal radiocephalic and brachiocephalic groups at 6 months were 63.3 and 65.1%, respectively, whereas the secondary patency rates at 6 months were 73.3 and 75.4%, respectively.
Conclusion
For patients with exhausted or unsuitable wrist vessels, we believe that a proximal radiocephalic, should precede creation of brachiocephalic fistula as it had nearly the same patency and complications rates but it avoided the risk of dialysis associated steal syndrome.

Keywords:
arteriovenous fistula, hemodialysis, steal syndrome

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Introduction

Forearm autogenous arteriovenous (AV) access has been recommended as the first choice for primary access for hemodialysis [1,2]. The distal radiocephalic arteriovenous fistula (AVF) at wrist is the gold standard venous access for patients who require long-term hemodialysis as it reduces the risk of steal syndrome compared with elbow fistulas and preserves more proximal vessels for future access placement. However, it has been reported to have a high primary failure rate because of early thrombosis or failure to mature enough to permit adequate dialysis [3]. Patients who have exhausted all forearm veins on both sides are suitable candidates for either forearm prosthetic access or upper-arm access of any type, however, autologous AVFs were suggested by more than one guideline [1].

Dialysis access-associated steal syndrome (DASS) is a serious complication associated with autogenous proximal arm fistulas, reported in up to 10–20% of patients [4,5]. Age greater than 60 years, female sex, concomitant peripheral vascular diseases, operations on the same limb, formation of proximal fistula, or use of synthetic graft have been identified as risk factors

predisposing to DASS [6]. The incidence of DASS in the patients with these risk factors range from 25 to 81% [7]. An alternative option is to create a proximal radiocephalic AVF between the proximal radial artery and the cephalic vein instead of brachial artery [8].

So in the absence of suitable vein at the wrist, a brachiocephalic fistula at elbow is usually constructed. To avoid complication of vascular steal syndrome associated with brachiocephalic fistula, an alternative operative technique involving the creation of radiocephalic, radiomedian cubital, or ulnobasilic fistula at the elbow [9].

The aim of this study was to evaluate proximal radiocephalic AVF versus brachiocephalic fistula for hemodialysis in patients with end-stage renal disease (ESRD) in terms of patency and incidence of complications.

Patients and methods

A prospective randomized study carried out between January 2016 and January 2017 and was followed up till July 2017 on 60 patients presented with ESRD with exhausted or unsuitable forearm veins on both sides, in need for vascular access for hemodialysis in outpatient clinic in Menoufia University Hospital. The patients were categorized randomly into two groups (brachiocephalic group including 30 patients and proximal radiocephalic group including 30 patients). This study was accepted and approved by ethical committee. An informed written consent was taken from all the patients.

All patients were subjected to examination of the vessels of both upper limbs including clinical and duplex examination of the veins and arteries.

The criteria included in this study were sex, age, and specific comorbidities (diabetes mellitus, hypertension, and hyperlipidemia).

Postoperative complications, such as steal syndrome, venous hypertension, aneurysm, stenosis, and bleeding were recorded.

Operative procedure

Proximal radiocephalic group

We ensured that the blood pressure of the patients was not less than 110/70, especially postdialysis. The operations were performed under local anesthesia using 1% lidocaine. After proper preoperative antibiotic prophylaxis, longitudinal or oblique incision (about 5–6 cm long) 1 cm distal to antecubital crease was used. The median antecubital vein was identified and dissected distally to the confluence of the cephalic vein, and then we dissect the communicating cephalic vein and the median cubital vein was ligated distally. After disconnection, the vein was distended and flushed with heparinized saline solution. The brachial artery was exposed in the median cubital fossa and dissected distally to expose the proximal radial artery. The radial artery was clamped and a 8–12-mm-long arteriotomy was performed about 2 cm distal to the brachial artery bifurcation. Then the communicating cephalic vein was anastomosed to the radial artery in end to side fashion using 6/0 polypropylene. The anastomosis length was ~5–8 mm, two to three times the internal diameter of the proximal radial artery (PRA). Clamps are then released and the anastomosis is checked. Fistula patency was confirmed on table by presence of a palpable thrill and/or a bruit, the wound was closed in layers. Skin closure was done with 4/0 prolene, and aspirin was given postoperatively.

Brachiocephalic group

The operation was done under local anesthesia. Transverse incision of about 4–5 cm was done, 1 cm above the elbow. The cephalic vein was identified and dissected as well as the brachial artery, then the distal end of the vein was ligated and anastomosed to the brachial artery after clamping of the artery.

Technical success was defined as the presence of a thrill on palpation or a bruit on auscultation immediately, and/or 24 h postoperatively. Primary patency was defined as hemodynamic patency without further intervention, and secondary (cumulative) patency when additional surgical or radiological procedures were performed to maintain fistula patency (whether on a thrombosed fistula or not).

Follow-up

Four to 6 weeks following the operation, the patients in both groups were examined by Duplex ultrasonography to check for the maturation of AVF (blood flow more than 500 ml per second in the fistula).

The patients who died, who underwent kidney transplantation, and in whom patency was not provided were excluded from the follow-up.

Statistical analysis

Data were collected, tabulated, statistically analyzed using an IBM personal computer with statistical

package of social science (SPSS), version 23, and Epi Info 2000 programs (SPSS Inc. Released 2015, IBM SPSS statistics for windows, version 23.0; IBM Corp., Armonk, New York, USA), where the following statistics were applied:

(1) Descriptive statistics: in which quantitative data were presented in the form of mean ($\overline{X}$), SD, range, and qualitative data were presented in the form numbers and percentages.
(2) Analytical statistics: Kaplan–Meier estimator curve is a nonparametric statistic used to estimate the survival function from life time data.

Results

Proximal radiocephalic group

The mean age of patients was 52.7±14.3 years ranging from 28 to 76 years. Male to female ratio was 1 : 2. Twenty four (80%) patients were diabetic, five (16.7%) patients had cardiovascular disease, 10 (33.3%) patients were hypertensive, five (16.7%) patients had ischemic heart disease while seven (23.3%) patients had previous failed AVF (Table 1). Primary fistula failure was not seen in any patient, while six (20%) fistulas failed later, four of them due to thrombosis, one due to anastomotic aneurysm and the other due to severe venous hypertension in which the fistula was ligated. Two (6.7%) patients were lost (censored) during the follow-up period, one of them died due to causes unrelated to dialysis and the other was lost in the follow up. No patients developed steal syndrome. Fistula thrombosis occurred in four (13.3%) patients during the first 6 months of follow up, thrombectomy was done in two patients but unfortunately failed, while not trialed in the other two patients because of thrombophlebitis of the vein and delay in time. One fistula (3.3%) showed weak flow (blood flow <200 ml/s within the fistula by duplex ultrasonography), after being sufficient due to anastomotic stenosis, and was salvaged by percutaneous balloon dilation. Anastomotic pseudoaneurysm occurred in two (6.7%) patients, in one case we succeeded to preserve the fistula by doing aneurysmorrhaphy of the vein, whereas in the other case fistula ligation was done. A partially thrombosed false aneurysm was found, with partial anastomosis disruption. A fragment of the pseudoaneurysm's wall was sent for a bacterial examination and a full course of antibiotics was given after the operation. Needle puncture pseudoaneurysm proximal to the fistula developed in one (3.3%) patient, and was successfully repaired by surgical excision of the aneurysm and direct repair of the vein. In one (3.3%), the cephalic vein was deep and required superficialization as a second stage, the vein was then needled successfully. Two (6.7%) patients developed upper-arm swelling, in one patient, edema is mild to moderate that was resolved with observation, limb elevation, and removal of central catheters, but in the other patient, edema was extensive and fistula was ligated (Table 2). Primary and secondary patency rates at 6 months were 63.3 and 73.3%, respectively (Figs 1 and 2).

Table 1 Associated comorbidities

Comorbid condition	Proximal radiocephalic group (*N*=30) [*n* (%)]	Brachiocephalic group (*N*=30) [*n* (%)]
Diabetes mellitus	24 (80)	20 (66.7)
Cardiovascular diseases	5 (16.7)	6 (20)
Hypertension	10 (33.3)	12 (40)
Ischemic heart diseases	5 (16.7)	3 (10)
Previous failed AVF	7 (23.3)	5 (16.7)

AVF, arteriovenous fistula.

Brachiocephalic group

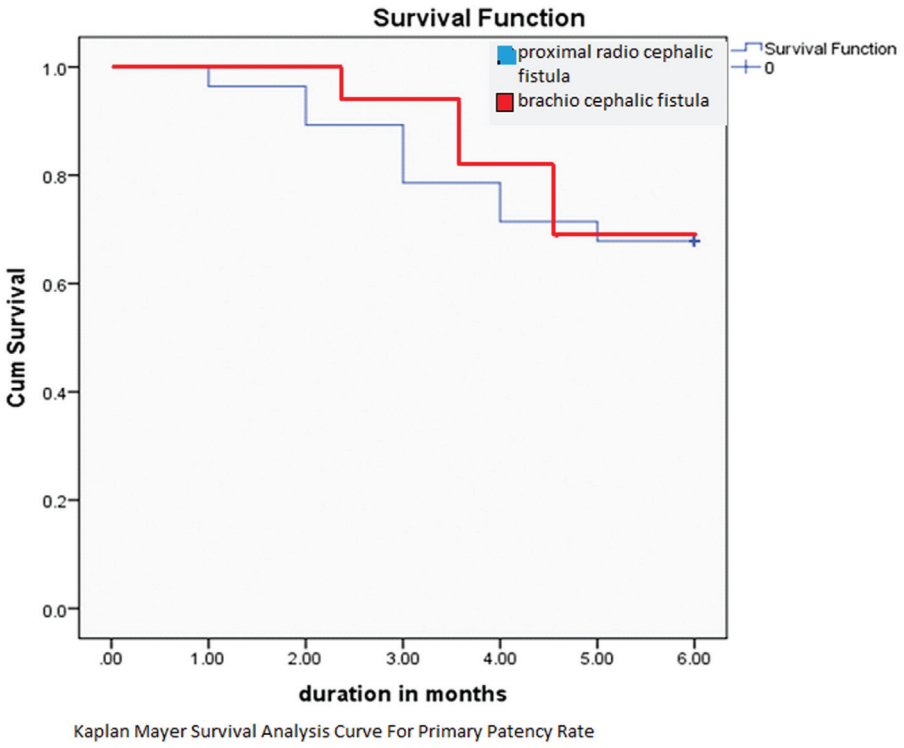
The age of patients ranged from 35 to 84 years with a mean of 63 years. Eighteen patients were male while 12 patients were female. Twenty (66.7%) patients were diabetic, six (20%) patients had cardiovascular disease, 12 (40%) patients were hypertensive, three (10%) patients had ischemic heart disease while five (16.7%) patients had previous failed AVF (Table 1). Primary fistula failure was not seen in any patient,

Table 2 Types of complications

Types of complications	Proximal radiocephalic fistula [*n* (%)]	Brachiocephalic fistula [*n* (%)]	Fisher's exact test	*P* value
Thrombosis	4 (13.3)	3 (10)	0.05	0.96
Dialysis associated steal syndrome	0	5 (16.7)	3.96	0.04*
Anastomotic stenosis	1 (3.3)	0	2.37	0.12
Anastomotic aneurysm	2 (6.7)	3 (10)	0.20	0.65
Needle puncture aneurysm	1 (3.3)	2 (6.7)	1.24	0.22
Venous hypertension	2 (6.7)	3 (10)	0.20	0.65

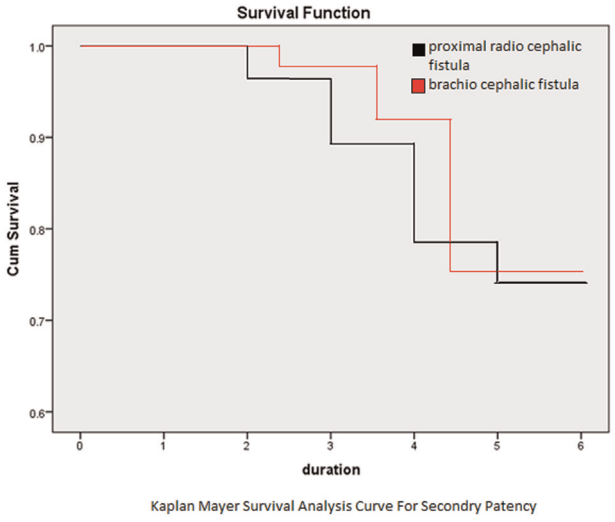
*Statistically significant *P* value.

Figure 1



Kaplan–Meier survival analysis for primary patency rate.

Figure 2



Kaplan–Meier survival analysis for secondary patency rate.

while six (20%) fistulas failed later, three of them due to thrombosis, one due to anastomotic aneurysm, one due to severe venous hypertension in whom the fistula was ligated and the last one due to steal syndrome. Five (16.7%) patients developed steal syndrome, two cases were mild and treated conservatively, two cases were managed by banding of the outflow cephalic vein while the last case was severe and needed ligation of the fistula. Fistula thrombosis occurred in three (10%) patients during the first 6 months of follow up, thrombectomy was done but unfortunately failed in the three cases. Anastomotic stenosis did not develop in any case. Anastomotic pseudoaneurysm occurred in three (10%) patients, in two cases we succeeded to preserve the fistula by doing aneurysmorraphy of the vein while in the third case fistula ligation was done. Needle puncture pseudoaneurysm proximal to the fistula developed in two (6.7%) patients and was successfully repaired by surgical excision of the aneurysm and direct repair of the vein. Three (10%) patients developed upper-arm edema, in two patients, edema was mild to moderate that was resolved with observation, limb elevation, and removal of central catheters, but in the third patient, edema was extensive and fistula was ligated (Table 2). Primary and secondary patency rates at 6 months were 65.1 and 75.4% respectively (Figs 1 and 2).

Discussion

A progressive rise in the number of patients accepted for renal replacement therapy has been reported worldwide, permanent vascular access is the life-line for the majority of these patients, when hemodialysis is the treatment of choice. Thus, the successful creation of permanent vascular access and the appropriate management to decrease the complications is mandatory, a well functional access is also vital in order to deliver adequate hemodialysis therapy in

ESRD [10]. The distal radiocephalic AVF described in 1966 by Brescia *et al*. [11] is considered the first procedure of choice followed by other potential options. However, when the distal veins are unavailable, exhausted, or had failed, especially in obese patients, or had calcified distal vessels are in need for alternative methods for surgical angioaccess [12]. Autogenous brachial artery fistulas are considered as a suitable option in these conditions. However, these fistulas are more commonly associated with development of DASS than wrist fistulas. Tordoir *et al*. [13] reported that symptomatic ischemia may develop in 10–25% of brachiocephalic and basilic AVFs, 4.3–6% of forearm prosthetic AVFs, and 1–1.8% of radiocephalic AVFs and this matches with the results in our study as the incidence of steal syndrome in the brachiocephalic group was 16.7%. In our study, we used proximal radial artery as a source of inflow in the proximal radiocephalic group instead of brachial artery to avoid steal syndrome as it has been used by many other authors [14]. In this study proximal radiocephalic AVF was done 30 patients with ESRD who had inadequate wrist veins, diabetics, previous failed distal AVF's, or severely atherosclerosed distal artery. The incidence of DASS is extremely rare following proximal radiocephalic AVFs [15]. Bruns and Jennings [16] found this fistula type to be safe and reliable with no incidence of steal after a 42 month follow up. All previous studies demonstrated a low incidence of steal syndrome (at 0–3%) compared to much higher (up to 20%) in brachiocephalic fistulas [13]. Our results were in concordant with previous reports as steal syndrome developed in five (16.7%) patients in the brachiocephalic group and did not develop in any patient in the proximal radiocephalic group (0%). In our series the proximal radial artery was used as inflow site, the median cephalic vein was used for venous outflow with end to side technique, when the proximal radial artery is used for the fistula, the hand is still supplied with blood via the ulnar artery and the vascular arcades of the hand [17].

Five (8.3%) patients developed anastomotic pseudoaneurysm in both groups. This was higher than with the 2–2.4% incidence reported by Zibari *et al*. [18], Elseviers and Van Waeleghem [19], and Padberg *et al*. [20]. The cause may be the higher incidence of infection in our environment and inadequate sterilization. Other frequent complications affecting the patency of fistulas include thrombosis, stenosis, infection, bleeding, and flow problems [19]. The results of attempted surgical revision after thrombosis in native fistulas is generally low. If the patients present promptly, an attempt to salvage the fistula can be made via a surgical thrombectomy with a fogarty catheter [21].

The first 24 h must be regarded as a critical period for the patency of fistulas. So that, in our study we did not do thrombectomy in two cases because of the delay in time. In end to side fistula, venous hypertension may be due to venous outflow obstruction at the regional level or central venous stenosis. Treatment is done by angioplasty to correct stenosis of the outflow venous channels. In our study this occurred in five (8.3%) patients in both groups, two (6.7%) patients in the proximal radiocephalic group and three (10%) patients in the brachiocephalic group, three of them managed successfully by conservative measures while the other two cases were ligated after failed trial of angioplasty.

Conclusion

For patients suffering from prior forearm AVF dysfunction, or having inadequate wrist vessels, we believe that a proximal radiocephalic fistula should precede creation of brachiocephalic fistula as it has nearly the same patency and complications rates but it avoids the risk of DASS.

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Nil.

Conflicts of interest

There are no conflicts of interest.

References

1 Sidawy AN, Spergel LM, Besarab A, Allon M, Jennings WC, Padberg FT Jr, *et al*. The society for vascular surgery: clinical practice guidelines for the surgical placement and maintenance of arteriovenous hemodialysis access. J Vasc Surg 2008; 48 (Suppl.):2s–25s.

2 Besarab A, Work J, Brouwer D, *et al*. Clinical practice guidelines for vascular access. Am J Kidney Dis 2006; 48 (suppl 1):S176–S247.

3 Mallik M, Sivaprakasam R, Pettigrew G, Callaghan C. Operative salvage of radiocephalic arteriovenous fistulas by formation of a proximal neoanastmosis. J Vasc Surg 2011; 54:168–173.

4 Morsy AH, Kulbaski M, Chen C, Isiklar H, Lumsden AB. Incidence and characteristics of patients with hand ischemia after a hemodialysis access procedure. J Surg Res 1998; 74:8–10.

5 Wixon CL, Hughes JD, Mills JL. Understanding strategies for the treatment of ischemic steal syndrome after hemodialysis access. J Am Coll Surg 2000; 191:301–310.

6 Goldfeld M, Koifman B, Loberant N, Krowll I, Haj M. Distal arterial flow in patients undergoing upper extremity dialysis shunting: a prospective study using Doppler sonography. Am J Roentgenol 2000; 175:513–516.

7 Elfstorm J, Lindell A. Limitations of the use of arteriovenous fistulae in the cubital fossa. Scand J Urol Nephrol 1994; 28:123–126.

8 Gracz KC, Ing TS, Soung LS, Armbruster KFW, Seim SK, Merkel FK. Proximal forearm fistula for maintenance hemodialysis. Kidney Int 1977; 11:71–74.

9 Kumar A, Jha M, Singla M, Gupta N, Raina P, Dubey D, *et al*. Radio-median cubital/radiocephalic arteriovenous fistula at elbow to prevent vascular steal syndrome associated with brachiocephalic fistula: Review of 320 case. Indian J Urol 2007; 23:261–264.

10 Feldman HI, Kobrin S, Wasserstein A. Hemodialysis vascular access morbidity. J Am Soc Nephrol 1996; 7:35–523.

11 Brescia MG, Cimino JE, Appel K. Chronic hemodialysis using venipuncture and a surgically created arteriovenous fistula. N Engl J Med 1966; 275:1089–1092.

12 Miller CD, Robbin ML, Allon M. Gender differences in outcomes of arteriovenous fistulas in hemodialysis patients. Kidney Int 2003; 63:346–352.

13 Tordoir JH, Dammers R, van der Sande FM. Upper extremity ischemia and hemodialysis vascular access. Eur J Vasc Endovasc Surg 2004; 27:1–5.

14 Wu CC, Jiang H, Cheng J, Zhao LF, Sheng KX, Chen JH. The outcome of the proximal radial artery arteriovenous fistula. J Vasc Surg 2015; 61:802–808.

15 Whittaker L, Bakran A. Prevention better than cure: avoiding steal syndrome with proximal radial or ulnar arteriovenous fistulae. J Vasc Access 2011; 12:318–320.

16 Bruns SD, Jennings WC. Proximal radial artery as inflow site for native arteriovenous fistula. J Am Coll Surg 2003; 197:58–63.

17 Tonks AM, Lawrence J, Lovie MJ. Comparison of ulnar and radial arterial blood-flow at the wrist. J Hand Surg [Br] 1995; 20:240–242.

18 Zibari GB, Rohr MS, Landrenau MD, Bridges RM, DeVault GA, Petty FH, *et al.* Complications from permanent haemodialysis vascular access. Surgery 1988; 104: 681–686.

19 Elseviers MM, Van Waeleghem JP. Identifying vascular access complications among ESRD patients in Europe: a prospective multicenter study. Nephrol News Issues 2003; 17:61–64.

20 Padberg FTJr, Calligaro KD, Sidawy AN. Complications of arteriovenous hemodialysis access: recognition and management. J Vasc Surg 2008; 48:55s–80s.

21 Murphy GJ, Saunders R, Metcalfe M, Nicholson ML. Elbow fistulas using autogeneous vein: patency rates and results of revision. Postgrad Med J 2002; 78:483–486.