

Original Article

A Comparative Study between Radiocephalic and Brachiocephalic Arteriovenous Fistula in End Stage Renal Disease

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Abstract

Keywords:
Chronic kidney disease, Arterio venous fistula, Haemodialysis.

Background: Chronic Kidney Disease (CKD) is a major health issue all over the world. Patients with deteriorating renal function and end-stage renal disease require vascular access for hemodialysis. Studies suggest that Arterio-Venous fistula (AVF) constructed judiciously using autologous conduit give the best outcome in this regard. Objective of the study was to compare the outcomes of Radiocephalic and Brachiocephalic AVF in end stage renal disease (ESRD).

Methods: It was a quasi-experimental study carried out at the Department of Vascular Surgery, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka. The study was conducted from June 2019 to May 2020. Patients suffering from ESRD underwent AVF creation surgery for hemodialysis access. A total of 60 (Sixty) patients were included in this study. The patients were divided into two groups; Group I included 30 patients who underwent Radiocephalic AVF operation and Group II included 30 patients who had Brachiocephalic AVF operation.

Results: In Group I, (Radiocephalic AVF) 60% were male and 40% were female. On the other hand, in Group II (Brachiocephalic AVF) 73.3% were male and 26.7% were female. Calculated volume flow (Q max) was significantly higher in Group II compared with Group I (769.11±101.54 ml/min vs 626.37±55.81) ml/min with the difference being statistically significant (P=0.001). Maturation time was significantly less in Group II compared with Group I (37.78±1.93 vs 43.33±2.12 days) with the difference between the two group being statistically significant (P=0.001). Complication was more in Group I than Group II (16.7% vs 3.3%).

Conclusion: The present study shows that Brachiocephalic AVF gives significantly better outcome in terms of shorter maturation time and less complications compared with Radio-Cephalic AVF. Color Doppler study is an essential tool for preoperative vessel evaluation which guides the selection of suitable AVF construction site.

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Introduction:

End-stage renal disease (ESRD) is defined as irreversible decline in a person's own kidney function, which is severe enough to be fatal in the absence of dialysis or transplantation. ESRD is included under stage 5 of the National Kidney Foundation Kidney Disease Outcomes Quality Initiative classification of

chronic kidney disease (CKD), where it refers to individuals with an estimated glomerular filtration rate less than 15 mL/minute/1.73 m² body surface area, or those requiring dialysis irrespective of glomerular filtration rate.^{1,2}

One major focus of Kidney Disease Outcome Quality initiative (KDOQI) is optimal arteriovenous

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(AV) access management, which has led to the creation of the National Vascular Access Improvement Initiative (NVAII) and its Fistula First campaign. KDOQI makes it clear that all patients with stage IV or stage V chronic kidney disease (CKD) who opt for hemodialysis should undergo autologous arterio-venous fistula (AVF) creation. In order to preserve viable access sites, they recommend a Radiocephalic AVF as the first and best option. If not feasible, then a brachiocephalic AVF, followed by a basilic vein transposition should be created in the non-dominant arm. Prosthetic arteriovenous bridge grafts and tunneled dialysis catheters are mentioned as last resorts in patients with no autologous options. These recommendations are based upon available data which suggest that AVF have superior patency, fewer complications, require fewer re-interventions, and ultimately improve patient survival.³

Cephalic vein in the forearm is superficial in most patients, which is easily damaged with previous venipunctures making Radiocephalic AVF creation difficult. On the other hand, Cephalic vein in the arm is relatively well preserved and surgical technique to create. Brachiocephalic AVF is also relatively simple. However, there is no consensus on which of these two types of AVF is to be preferred.⁴ The present study was conducted with the aim to compare the overall outcomes and complications of Radiocephalic and Brachiocephalic AVF for hemodialysis in patients with ESRD.

Study Methods

It was a quasi-experimental study carried out at the Department of Vascular Surgery, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka during the period of June 2019 to May 2020. A total 60 ESRD patients who required AVF creation for hemodialysis were enrolled in the study. The patients were divided into two groups; Group I included 30 patients who underwent Radiocephalic AVF operation and Group II included 30 patients who had Brachiocephalic AVF operation. In Group I, Radiocephalic AVF was created using Radial artery and Cephalic vein in an end to side fashion while in Group II Brachiocephalic AVF was constructed between Brachial artery and Cephalic vein using end to side anastomosis. Doppler study was done before every

procedure for meticulous vessel evaluation for suitability to be used as conduit. Doppler study was again done after procedure to demonstrate the velocity, volume of blood flow, depth from the skin, diameter of vessels.

The operation was done under local anesthesia. Incision of about 4–5 cm was done, just above the elbow and 3-5 cm above the wrist for Brachiocephalic and Radiocephalic fistula, respectively. The cephalic vein was identified and dissected as well as the Brachial or Radial artery. The distal end of the vein was ligated and anastomosed to the Brachial or Radial artery after clamping the artery. Technical success was defined as the presence of a thrill on palpation or a bruit on auscultation immediately, and/or after 24 hours postoperatively. Primary patency was defined as hemodynamic patency without further intervention, and secondary (cumulative) patency when additional surgical or endovascular procedures were performed to maintain fistula patency (whether on a thrombosed fistula or not). Four to six weeks following the operation, the patients in both groups were examined by Duplex ultrasonography to check for the maturation of AVF including flow volume measurement in the fistula). Data analysis was carried out by using the Statistical Package for Social Science (SPSS) version 20.0 windows software. Correlation of data was done by Pearson's or spearman correlation coefficient. Continuous data was expressed as mean \pm SD. Categorical data was expressed as frequency and percentages. Comparison of quantitative data was done by unpaired t-test. Comparison categorical data was done by chi-square test. p value of <0.05 was considered as significant.

Results:

Age distribution of the patients shows that in Group I, 10% were in age group 19-30 years, 26.7% in 31-45 years, 36.7% in 46-60 years and 26.7% in >60 years. On the other hand, in Group II, 13.3% were in age group 19-30 years, 40% in 31-45 years, 16.7% in 46-60 years and 30% in >60 years. The average age was 50.46 ± 14.28 years in Group I and 46.50 ± 16.47 years in Group II. Regarding sex, 60% were male and 40% were female in Group I and 73.3% were male and 26.7% were female in Group II. (Table I)

Preoperative Duplex for Radiocephalic AVF showed that Q Max were higher in Brachial artery than in Radial artery (121.33±13.50 ml/min vs 41.70±9.68 ml/min). It also shows flow volume in cephalic vein at elbow was higher than that in cephalic vein at wrist (26.43±4.64 ml/min vs 18.43±3.48 ml/min). Mean depth from skin (mm) was 4.39±0.26 for Brachial artery, 1.84±0.15 for Cephalic vein at elbow, 2.71±0.20 for Radial artery and 2.43±0.16 for Cephalic vein at wrist. Diameter (mm) was 3.03±0.12 for brachial artery, 2.85±0.13 for cephalic vein at elbow, 2.77±0.10 for Radial artery and 2.64±0.10 for Cephalic vein at wrist (Table II).

On preoperative Duplex for Brachiocephalic AVF, Q Max was higher in Brachial artery than Radial artery which was 109.85±25.44 vs 28.96±7.03 respectively. It also shows cephalic vein at elbow was higher than cephalic vein at wrist which was 28.46±8.33 vs 16.07±3.94 respectively. Mean depth

from skin (mm) was 3.38±0.38 in Brachial artery, 1.25±0.23 in Cephalic vein at elbow, 2.37±0.38 in Radial artery and 2.20±0.22 in Cephalic vein at wrist. Diameter (mm) was 3.02±0.17 for Brachial artery, 2.53±0.23 for Cephalic vein at elbow 2.02±0.22 for Radial artery and 1.60±0.23 for Cephalic vein at wrist (Table III).

Postoperative Duplex Scan showed that Q max was statistically significantly higher in Brachiocephalic AVF patients than Radiocephalic AVF patient (769.11±101.54 vs 626.37±55.81) (p=0.001). Maturation time was statistically significantly shorter for Brachiocephalic AVF compared with Radiocephalic AVF patients (37.78±1.93 vs 43.33±2.12 days) (p=0.001). (Table IV).

Complication was more in Radiocephalic AVF patients (Group I) than Brachiocephalic AVF patients (Group II) which was 16.7% vs 3.3% respectively (Table V)

Table-I
Demographic characteristics of the study subjects (N=60).

Characteristics	Group I(n=30)		Group II(n=30)		p value
	No	%	No	%	
Age in years					
19-30	3	10.0	4	13.3	0.354
31-45	8	26.7	12	40.0	
46-60	11	36.6	5	16.7	
>60	8	26.7	9	30.0	
Mean ± SD	50.46±14.28	46.50±16.47			
Sex					
Male	18	60.0	22	73.3	0.273
Female	12	40.0	8	26.7	
Male/female ratio	1.5:1		2.7:1		

Data were analyzed using chi-square test

Group I= (Radiocephalic arteriovenous fistula patients)

Group II = (Brachiocephalic arteriovenous fistula patients)

Table-II
Preoperative Duplex in Radio cephalic arteriovenous fistula (n=30).

	Brachial artery	Cephalic vein at elbow	Radial artery	Cephalic vein at wrist
Q Max	121.33±13.50	26.43±4.64	41.70±9.68	18.43±3.48
Mean depth from skin (mm)	4.39±0.26	1.84±0.15	2.71±0.20	2.43±0.16
Diameter (mm)	3.03±0.12	2.85±0.13	2.77±0.10	2.64±0.10

Table-III
Preoperative Duplex in Brachiocephalic arteriovenous fistula (n=30).

	Brachial artery	Cephalic vein at elbow	Radial artery	Cephalic vein at wrist
Q Max	109.85±25.44	28.46±8.33	28.96±7.03	16.07±3.94
Mean depth from skin (mm)	3.38±0.38	1.25±0.23	2.37±0.38	2.20±0.22
Diameter (mm)	3.02±0.17	2.53±0.23	2.02±0.22	1.60±0.23

Table-IV
Post-operative Colour Doppler (n=60).

	Group I (n=30)	Group II (n=30)	p value
Q Max	626.37±55.81	769.11±101.54	0.001
Maturation	43.33±2.12	37.78±1.93	0.001

Data were analyzed using 't' test

Group I= (Radiocephalic arteriovenous fistula patients)

Group II = (Brachiocephalic arteriovenous fistula patients)

Table-V
Complication of the procedure between two groups (n=60).

Complication	Group I (n=30)		Group II (n=30)		p value
	No	%	No	%	
Pseudoaneurysm	1	3.3	0	00	0.198
Infection, Bleeding, Wound gaping	3	10.0	0	00	
Thrombosis	1	3.3	0	00	
Ecchymosis	0	00	1	3.3	

Data were analyzed using chi-square test

Group I= (Radiocephalic arteriovenous fistula patients)

Group II = (Brachiocephalic arteriovenous fistula patients)

Discussion:

Chronic kidney disease (CKD) is a long-term condition caused by damage to both kidneys. AVF has been the vascular access of choice for hemodialysis because of lower cost, morbidity and mortality.⁵ Vascular access is a necessity for patients with ESRD who need chronic intermittent hemodialysis. According to Kidney Disease Outcomes Quality Initiative (KDOQI) guidelines, Radial-Cephalic (RC) and Brachial-Cephalic (BC) AVF are the first and second choice for vascular access, respectively. Surgical AVF is a simple day care procedure. It is important to have a good result as the surgeon's works is purely a technical job and not the main management in the disease process. So, a well-executed surgery gave good results and hence the choice of choosing the proper site makes a difference in the final outcome. The

objectives of this study were to compare the outcomes of Radiocephalic and Brachiocephalic arteriovenous fistula in end stage renal disease. The present study findings were discussed and compared with previously published relevant studies.

In present study shows in Radiocephalic group out of total 30 patients 18(60%) were males and 12(40%) were females. In Brachiocephalic group out of total 30 patients 22 (73.3%) were males and 8(26.7%) were females. In Radiocephalic group it was 1.5:1 and Brachiocephalic group male to female ratio was 2.7:1. This finding consistent with other studies.⁶⁻⁸

In this study, blood flow, diameter and depth from skin in brachial artery & cephalic vein at elbow, and radial artery and cephalic vein at wrist are in

well agreement with the findings of the other research works.^{5,6,9}

This study shows that the postoperative flow rate (volume of blood flow through AVF) was significantly higher for the Brachiocephalic AVF than that of the Radiocephalic AVF. Hence it can be concluded that Brachiocephalic AVF matured earlier than Radiocephalic AVF is with more flow rate. Therefore, the findings of the study are in well agreement with the findings of the other research works.⁵

This study shows Brachiocephalic AVF matured significantly earlier than Radiocephalic AVF. This finding is consistent with the study of Khadatkhar et al.⁵ they found the mean time for maturation was 43.78 ± 3.43 and 37.59 ± 3.309 days for Radiocephalic and Brachiocephalic fistula, respectively. Another study Verma et al.⁶ shows the mean time for maturation was 42.83 ± 2.78 and 36.13 ± 2.58 days for Radiocephalic and Brachiocephalic fistula, respectively.

Pisoni RL et al.¹⁰ in his study found no significant difference in AV fistula survival whether the AV fistula was first cannulated within 15 to 28 days or had a longer maturation period of 43 to 84 days. However, AV fistula cannulation within 14 days of creation was associated with a 2.1-fold increased risk of subsequent AV fistula failure compared with AV fistulas cannulated at more than 14 days.

Saran et al.¹¹ suggested that cannulation of AV fistulae <2 weeks old should be avoided, Cannulation between 2 and 4 weeks should be performed only if the fistula is deemed mature by the treating nephrologists/surgeon and under close supervision, electively and never as an emergency. It is probably safe to cannulate a fistula after 4 weeks of creation. Robbin et al.¹² and Petrovic D¹³ were fulfilled by Brachiocephalic AVF significantly earlier (mean 37.59days) than the Radiocephalic (mean 43.78 days) suggesting that the Brachiocephalic AVF matured significantly earlier than the Radiocephalic AVF. According to the findings of Petrovic D¹³, Beathard GA et al.¹⁴ for maturation of AVF, both Brachiocephalic AVF group and Radiocephalic AVF group matured in coherence to these studies.

In present study the overall complication was seen in 6 (10%) patients out of 60. Complication found

that infection, bleeding and wound gaping, pseudoaneurysm, thrombosis. It concluded that Radiocephalic arteriovenous fistula were higher complication than Brachiocephalic arteriovenous fistula. This finding is consistent with Khadatkhar et al.⁵

Hammes et al.¹⁵ stated that complications occur in approximately one-third of fistulas and include: aneurysms, infection, stenosis, thrombosis, steal syndrome and heart failure. Beathard GA et al.¹³ in his study said that the AVF is associated with fewer complications than are seen with other types of vascular access, they do occur and they should be dealt with effectively. He categorizes the major complications that are seen in conjunction with arteriovenous fistulas under the headings of early failure, late failure, excessive flow, aneurysm formation and infection. Both early and late failures have multiple causes.

Steal syndrome was observed in 0.3 % in case of Radiocephalic AV fistula and 1.8 % in case of Brachiocephalic fistula. To prevent arterial steal following hemodialysis access, strategies were taken which were 1. Preoperative testing to identify proximal arterial lesions, 2. Minimize use of brachial artery inflow. 3. Selective venous arterialization at elbow with ligation of deep perforating branch.¹⁷ No patient was found having steal syndrome in this study.

Conclusion:

This study shows that the Brachiocephalic arteriovenous fistula maturation time was significantly less than the maturation time of Radiocephalic AVF. The flow rate was more for Brachiocephalic arteriovenous fistula than Radiocephalic arteriovenous fistula. The rate of complication was less in Brachiocephalic arteriovenous fistula as compared to Radiocephalic arteriovenous fistula. It may be concluded that Brachiocephalic arteriovenous fistula was more effective than Radiocephalic arteriovenous fistula.

Conflict of Interest - None.

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