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Outcome of end to side and side to side arteriovenous anastomosis in creating radiocephalic fistula of patients suffering from end stage renal disease

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Abstract

A radiocephalic arteriovenous fistula (AVF) is the preferred access method for hemodialysis (HD). The End-to-Side (ETS) anastomosis technique has been suggested to yield better outcomes compared to the Side-to-Side (STS) approach; however, there is limited evidence directly comparing the two methods. Given this, the present study aimed to evaluate and compare the outcomes of ETS and STS techniques in creating radiocephalic fistulas for end-stage renal disease (ESRD) patients. This quasi-experimental study was conducted in the Department of Urology at Sir Salimullah Medical College Mitford Hospital, Dhaka, over a 12-month period (May 2022 to April 2023) following ethical approval. A total of 74 ESRD patients requiring permanent vascular access for maintenance HD were enrolled, with 37 patients undergoing ETS AVF (Group A) and 37 patients receiving STS AVF (Group B). Postoperative follow-ups were conducted on the third day, as well as at the 6th and 12th weeks, using clinical evaluations, patient history, and investigations. Data were collected using structured case record forms and analyzed using SPSS 24.0. Baseline characteristics such as age, sex, and comorbidities were similar between the two groups. At the 6th week, maturation was observed in 78.4% of Group A patients compared to 48.6% in Group B, with the difference being statistically significant ($p < 0.05$). Primary patency was recorded in 91.9% of Group A and 67.6% of Group B at the 6th week, and in 86.5% of Group A and 59.4% of Group B at the 12th week, both showing a significantly higher patency rate in Group A ($p < 0.05$). Regarding postoperative complications, early thrombosis occurred in 5.4% of Group A patients versus 24.3% in Group B, while juxta-anastomotic stenosis was observed in 2.7% of Group A and 16.2% of Group B. Early thrombosis was significantly lower in Group A than in Group B ($p < 0.05$). The study found no significant association between outcomes and age or gender in either group ($p > 0.05$). Based on these findings, it can be concluded that the End-to-Side anastomosis technique is superior to the Side-to-Side approach for creating radiocephalic fistulas in ESRD patients, offering higher primary patency rates and better maturation outcomes.

Keywords: Arteriovenous fistula, arteriovenous grafts, end stage renal disease, duplex ultrasonography, kidney disease outcomes and quality initiative, maintenance hemodialysis, renal replacement therapy

Introduction

End-stage renal disease (ESRD) is a global health-care burden that is steadily increasing (Saran *et al.* 2019) [11]. Despite tremendous advances in the field of kidney transplantation over the last few decades, hemodialysis remains a logical and reasonable treatment option for renal replacement therapy among ESRD patients with all requiring vascular access to execute this procedure (Agarwal *et al.* 2019) [1]. AVF is the preferred route of access for long-term hemodialysis around the world (Bashar *et al.* 2015; Añel, Yevzlin and Ivanovich 2003). There is consensus on the location of main AVF development (Gilmore 2006; Sidawy *et al.* 2008) [4]; however, data supporting the use of side-to-side (STS) versus end-to-side (ETS) anastomosis is inadequate.

Incidence rates of treated ESKD remained generally steady in many higher-income nations from 2003 to 2020, but increased significantly in East and Southeast Asia (Thurlow *et al.* 2021) [12].

In Bangladesh, around 20 million individuals suffer from chronic kidney disease. Among them 35,000–40,000 develop end-stage renal disease each year (Rashid *et al.* 2021) ^[9]. Autogenous arteriovenous fistula (AVF) is the preferred method of choice to achieve vascular access for long-term hemodialysis. (Almasri *et al.* 2016; Vascular Access Work Group 2006;) ^[2] Because it has a low rate of complications and increases overall survival compared to other types of vascular access (Sands 2007; Añel *et al.* 2003; Bashar *et al.* 2015) ^[10, 4]. In the creation of an arteriovenous fistula, the radio-cephalic fistula is considered initially (Culleton 2006) ^[5], because of its proximal location and easily accessibility. In uremic patients, the most common kinds of AVF anastomosis are vein end to arterial end (ETE), vein side to arterial end (STE), vein end to arterial side (ETS), and vein side to arterial side (STS) (Weigang *et al.* 2021) ^[13].

In terms of early maturation and cumulative patency rates, data suggests that the side- to-side layout produces better results. This is because early thrombus formation is less common, which is the most common cause of fistula failure (O'Banion, Van Buren and Davis 2015) ^[8]. Side-to-side arrangement, on the other hand, is linked to a higher risk of venous hypertension, whereas end-to-side has the highest proximal venous blood flow rate and a lower risk of venous hypertension. Previous research has found that a radio-cephalic fistula in the form of a side-to-side anastomosis combined with distal cephalic vein closure reduces the incidence of venous hypertension (Hong *et al.* 2013) ^[7]. The development of end-to-side fistulas remains the prevailing practice and preferable procedure among vascular surgeons, Its because there is a lack of evidence clearly establishing the superiority of the side-to-side arrangement (Bashar *et al.* 2016) ^[3]. Despite the fact that all three renal replacement therapy methods (hemodialysis, peritoneal dialysis, and kidney transplantation) are conducted in Bangladesh, only 25% of end-stage renal disease patients have access to treatment due to insufficient facilities and excessive healthcare expenses (Rashid *et al.* 2021) ^[9]. There is limited data available regarding AVF techniques and their efficacy. So, result of this study will discover noble information and helps surgeon in choosing better method in creation of AV fistula.

An adequate vascular access is essential in end stage renal disease patients who are candidates for permanent hemodialysis or dialysis on a regular basis. Arteriovenous Fistula is the gold standard for vascular access for hemodialysis, with an overall success rate of approximately 84%, and is intended to improve dialysis effectiveness. However, for Bangladeshi patients, there is a notable lack of population-based data to guide this decision. Current data suggests that arteriovenous fistula (AVF) is a more favorable vascular access point with the radio-cephalic approach being recommended for long- term hemodialysis planning. End to Side anastomosis is preferable in clinical practice due to increased proximal venous flow, longer fistula life, and fewer long-term problems. Side to Side anastomosis is the most often utilized and easiest to create approach with the maximum fistula flow but it has the highest risk of venous hypertension. However, controversy exists about side-to-side anastomosis with distal cephalic

vein ligation in creating radio-cephalic arteriovenous fistula regarding outcomes and efficacy. Again, very few study found that there is no significant difference in between side-to-side anastomosis and end-to-side anastomosis techniques regarding outcomes, even end-to-side technique is better than side-to-side technique in creating radio-cephalic arteriovenous fistula. So, this study is designed to compare the side-to-side anastomosis with end-to-side anastomosis radio-cephalic fistula to see which is superior. Besides, in Bangladesh side-to-side anastomosis and end-to-side anastomosis has been performed sporadically, but there are lack of data regarding the outcomes and comparison in between ETS and STS arteriovenous fistula. The results of this study may generate important evidence for physicians which will eventually help patients as well. The findings may offer invaluable insights for surgeons, facilitating more informed decisions on the best method for AVF creation. Such insights may not only enhance patient care but may also pave the way for comprehensive national guideline formulation in treating end stage renal disease patients.

Materials and Methods

This quasi-experimental study was conducted in the Department of Urology at Sir Salimullah Medical College Mitford Hospital, Dhaka, over 12 months (May 2022 to April 2023) to compare End-to-Side (ETS) and Side-to-Side (STS) anastomosis techniques in creating radio-cephalic arteriovenous fistulas (AVFs) for end-stage renal disease (ESRD) patients requiring permanent vascular access for maintenance hemodialysis. A total of 74 patients meeting the inclusion criteria were enrolled, with 37 assigned to Group A (STS anastomosis with distal cephalic vein ligation) and 37 to Group B (ETS anastomosis). Patients with prior AVF surgery, unsuitable wrist vessels (determined via duplex ultrasound and physical examination), or other vascular abnormalities were excluded. Purposive sampling with alternate assignment was used. Data were collected from patient history, clinical examinations, investigation reports, and procedural complications, and analyzed using SPSS 24.0. Continuous data were expressed as mean \pm standard deviation, while categorical data were reported as frequencies and percentages. Chi-square and Fisher's exact tests were used for categorical variables, and independent t-tests were used for continuous variables, with statistical significance set at $p < 0.05$. Ethical approval was obtained from the Institutional Review Board (IRB), and informed written consent was secured from all participants. Patients were assured of confidentiality, adequate treatment for complications, and the freedom to withdraw at any stage of the study.

Results

This Quasi-experimental study was conducted in the Department of Urology, Sir Salimullah Medical College Mitford Hospital. A total of 74 End stage renal disease patients requiring permanent vascular access surgery for maintenance hemodialysis was enrolled in the study. Among them radio cephalic fistula was created by end to side technique in 37 patients (Group A) and side-to-side technique in 37 patients (Group B).

Table 1: Distribution of the patients according to Age group (N=74)

Age group (years)	Group A (n=37)	Group B (n=37)	p-value
20 to 29	3 (8.1)	2 (5.4)	
30 to 50	24 (64.9)	26 (70.3)	0.866*
51 to 70	10 (27)	9 (24.3)	
Mean ±SD	44.03±9.6	45.19±10.3	0.618**

p-value was determined by *Fisher Exact test and **Independent sample t test.

Data was presented with frequency (%) and mean ± SD and within parenthesis percentage over column in total.

Group A= Patients who had end-to-side AVF

Group B= Patients who had side-to-side AVF

Table 2: Distribution of the patients according to comorbidities (N=74)

	Group A (n=37)	Group B (n=37)	p-value
Diabetes mellitus			
Present	21 (56.8)	19 (51.4)	0.816
Hypertension			
Present	17 (45.9)	15 (40.5)	0.815
Glomerulonephritis			
Present	15 (40.5)	13 (35.1)	0.326

p-value was determined by *Chi-square test. Data was presented with frequency (%) and within parenthesis percentage over column in total

Group A= Patients who had end-to-side AVF Group B= Patients who had side-to-side AVF

Table 3: Distribution of the patients according to maturation rate at 6th weeks (N=74)

Maturation at 6 th week	Group A (n=37)	Group B (n=37)	p-value
Yes	29 (78.4)	18 (48.6)	
			0.015
No	8 (21.6)	19 (51.3)	

p-value was determined by *Chi-square test. Data was presented with frequency (%) and within parenthesis percentage over column in total

Group A= Patients who had end-to-side AVF Group B= Patients who had side-to-side AVF

Table 4: Distribution of the patients according to primary patency (N=74)

Primary patency	Group A (n=37)	Group B (n=37)	p-value
At 6th week			
Present	34 (91.9)	25 (67.6)	0.019*
At 12th week			
Present	32 (86.5)	22 (59.4)	0.017**

p-value was determined by *Fisher Exact test and **Chi-square test. Data was presented with frequency (%) and within parenthesis percentage over column in total

Group A= Patients who had end-to-side AVF Group B= Patients who had side-to-side AVF

Table 5: Distribution of the patients according to complication (N=74)

Complications	Group A (n=37)	Group B (n=37)	p-value
Early thrombosis			
Present	2 (5.4)	9 (24.3)	0.046
Juxta-anastomotic stenosis (JAS)			
Present	1 (2.7)	6 (16.2)	0.107

p-value was determined by *Fisher Exact test. Data was presented with frequency (%) and within parenthesis percentage over column in total

Group A= Patients who had end-to-side AVF Group B= Patients who had side-to-side AVF

Table 6: Association of age group with outcome in Group A (N=37)

Group A				Group B				
	20-29	30-50	51-70	p-value	20-29	30-50	51-70	p-value
Maturation at 6th week								
Yes	2 (66.7)	19 (79.2)	8 (80)	0.843	0 (0)	15 (57.7)	3 (33.3)	0.186
Primary patency at 6th week								
Present	3 (100)	22 (91.7)	9 (90)	1.00	2 (100)	17 (65.4)	6 (66.7)	1.00
Primary patency at 12th week								
Present	3 (100)	20 (83.3)	9 (90)	1.00	2 (100)	14 (53.8)	6 (66.7)	0.614

p-value was determined by *Fisher Exact test. Data was presented with frequency (%) and within parenthesis percentage over column in total.

Table 7: Association of gender with outcome in Group A (N=37)

Group A			Group B			
	Male	Female	p-value	Male	Female	p-value
Maturation at 6th week						
Yes	21 (75)	8 (88.9)	0.649	13 (44.8)	5 (62.5)	0.447
Primary patency at 6th week						
Present	26 (92.9)	8 (88.9)	1.00	21 (72.4)	4 (50)	0.394
Primary patency at 12th week						
Present	24 (85.7)	8 (88.9)	1.00	19 (65.5)	5 (62.5)	0.228

p-value was determined by *Fisher Exact test. Data was presented with frequency (%) and within parenthesis percentage over column in total.

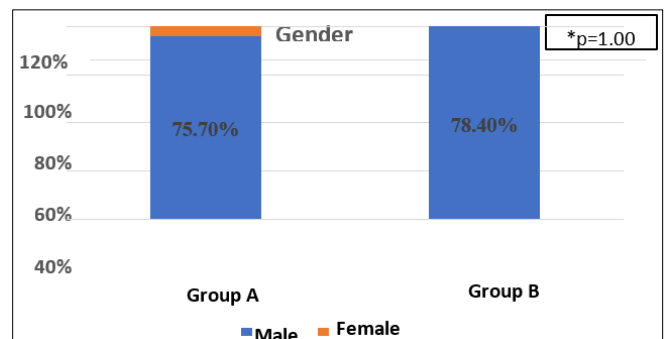


Fig 1: Distribution of the patients according to gender (n=74)

p-value was determined by *Chi-square test. Group A= Patients who had end-to-side AVF Group B= Patients who had side-to-side AVF

Discussion

A well-functioning vascular access is essential for the quality of life and clinical outcomes of hemodialysis patients. For individuals with end-stage renal disease (ESRD) undergoing maintenance hemodialysis, an arteriovenous fistula (AVF) is the preferred access option. The surgical technique used in AVF creation plays a crucial role in its long-term success, with end-to-side (ETS) and side-to-side (STS) anastomosis being the two widely adopted methods. While some studies suggest that STS anastomosis facilitates early maturation and improved cumulative patency (Tan & Atik, 2010), others report that ETS anastomosis results in higher patency rates and fewer complications (Khan *et al.*, 2015). This study aimed to compare the outcomes of ETS and STS anastomosis in radio-cephalic AVF creation among ESRD patients. A total of 74 patients were enrolled, with 37 undergoing ETS (Group A) and 37 undergoing STS (Group B). Findings indicated that at six weeks, maturation was significantly higher in Group A (78.4%) compared to Group B (48.6%). Primary patency was also superior in Group A at both six weeks (91.9% vs. 67.6%) and twelve weeks (86.5% vs. 59.4%). These results align with Elkassaby *et al.* (2021), who reported a primary technical success rate of 97% and significantly higher maturation in the ETS group. Previous studies also support the superior efficacy of ETS over STS (Khan *et al.*, 2015; Bashar *et al.*, 2016) [3]. Regarding complications, early thrombosis and juxta-anastomotic stenosis were more prevalent in Group B (24.3% and 16.2%, respectively) compared to Group A (5.4% and 2.7%), with early thrombosis showing statistical significance. Although earlier research reported comparable complication rates between the two methods, STS anastomosis was associated with higher arterial steal syndrome risk (Bashar *et al.*, 2016; Elkassaby *et al.*, 2021) [3]. The study also found no significant association between maturation and patency rates with age, as most patients were between 30 to 50 years old, consistent with previous research (Khan *et al.*, 2015; Hong *et al.*, 2013; Elkassaby *et al.*, 2021) [7]. Gender distribution was male-dominant in both groups, and maturation and patency rates showed no statistical differences between males and females, similar to prior findings (Hong *et al.*, 2013; Khan *et al.*, 2015; Elkassaby *et al.*, 2021) [7]. Overall, this study reinforces the superiority of ETS anastomosis over STS in terms of higher primary patency, better maturation rates, and fewer complications, making it the preferred approach for radio-cephalic AVF creation in ESRD patients.

Conclusion

This study assessed the outcomes of end-to-side (ETS) and side-to-side (STS) arteriovenous anastomosis in patients with end-stage renal disease undergoing hemodialysis. The findings revealed that ETS demonstrated a significantly higher maturation rate and primary patency while exhibiting fewer complications, including early thrombosis and juxta-anastomotic stenosis, compared to the STS technique. Therefore, it can be concluded that ETS anastomosis is superior to STS for radio-cephalic fistula creation in terms of improved primary patency and higher maturation rates.

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