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Aneurysmorrhaphy vs Bypass Graft during Arteriovenous Fistula Aneurysm Management in End Stage Renal Disease Patients.

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Abstract

Background: **Aneurysmal dilatation is considered one of the most common complications that may threaten the function of AVF and even the life of the patient if ruptured. To date, there is no gold standard approach for the management of AVF aneurysms.** ***Objectives:*** **To compare the outcome of aneurysmorrhaphy bypass graft regarding the patency and complication rates.** ***Methods:*** **This uncontrolled comparative clinical trial was conducted at Suez Canal University Hospital. Sixty-four patients were equally and randomly allocated into either Aneurysmorrhaphy or bypass graft group. Hemodialysis adult patients with aneurysmal functioning AVF were included in this study. Patients with upper limb ischemia, thrombosed AVF aneurysm, or hypotension were excluded.** ***Results:*** **The mean age of the studied patients was 39.8± 8.6 years. There was no significant variation either in the flow rate or in preoperative maximum diameter between the two groups. Postoperative maximum diameter was significantly higher among aneurysmorrhaphy (12.9± 3.4 mm) compared to bypass graft (6 mm) one day, one-month, and six-month postoperative with a significant decrease in the diameter of both groups compared to the preoperative diameter. Post-operative edema, hematoma, and thrombosis were higher in group A, while after six months infection and thrombosis were higher in group B.** ***Conclusion:*** **Aneurysmorrhaphy showed higher patency outcomes, post-operative maximum diameter, and thrombosis. While the bypass graft showed a higher incidence of infection.**

Keywords: Aneurysmorrhaphy, hemodialysis, bypass graft.

Introduction

Hemodialysis, via Arterio-venous access (AVF) access, was developed as a temporary treatment for End Stage Renal Disease Patients who wait for transplantation[(1)]. Nearly 30% of AVFs result in short- and long-term side effects (eg, thrombosis, stenosis, and aneurysm formation) [(2)]. Risk factors associated with AVFs include hypertension, diabetes, peripheral arterial disease, early AVF puncture, and

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repeated punctures of the same site [3]. AVF aneurysmal formation is a serious side effect [4]. Continued high-pressure blood flow and multiple punctures on the side of the vein can weaken the vein wall and form an aneurysm. AVF aneurysms can be either true aneurysms (containing all vessel wall elements) or pseudoaneurysms (adjacent soft tissue spaces that communicate with the lumen of the access site) [5].

The incidence of aneurysms requiring treatment has been reported to be approximately 5% to 7% of autologous AVFs [6,11,12]. Various treatment modalities have been proposed, including access ligation, aneurysm repair, resection and graft exchange, and the use of stent grafts [13]. However, most published series are small and lack adequate follow-up. Lack of studies comparing different treatment modalities [6].

The safest treatment option is to ligate the fistula and create a new access site. It can be salvaged with some surgical options, such as partial removal of the aneurysm wall (Aneurysmorrhaphy) and resizing the vein to create a conduit suitable for future cannulation. Other procedures include ligation of the aneurysm portion and bypass or graft interposition [7]. To date, there is no gold standard treatment for AVF aneurysms. Therefore, the main objective is to prevent further complications such as rupture, infection, bleeding, and overlying skin erosion [8].

Therefore, in the present study, we will assess and compare the outcomes of aneurysmorrhaphy vs surgical exclusion of the aneurysm by bypass graft in terms of intra and postoperative complications and the patency rates [9].

Subjects and Methods

The study was done in Suez Canal University Hospital, Vascular Surgery Unit from May 2022 to May 2023. This study was approved by the Local Ethics Committee (April 2022).

This uncontrolled comparative clinical trial. conducted at Suez Canal University Hospital, included 64 patients randomly selected from the Vascular Surgery outpatient clinic suffering from aneurysmal dilatation in their hemodialysis access. Patients were randomly allocated to either group A (managed with aneurysmorrhaphy surgery) or group B (managed with bypass graft), Hemodialysis adult patients with aneurysmal functioning AVF were included in this study, while patients with thrombosed aneurysm, hypotension, AVF with synthetic graft, or infected aneurysm were excluded from this study.

Preoperative assessment

Detailed medical history of personal data, duration of dialysis, age of the AVF, chronic illness, and drug intake. Clinical examination including measuring blood pressure, temperature, and AVF assessment for any gross infection and Duplex assessment was done routinely for all patients to assess the following:

(a) Detailed vascular mapping (arterial diameter, venous diameter and length, and fistula flow).
(b) Determination of presence of abscesses or signs of infection.
(c) Difference between hematoma and pseudoaneurysm (often manifesting as a B-mode pulsatile echogenic sac with a swirling flow pattern and a characteristic "to and fro" flow pattern in spectral waveform analysis).
(d) Whether the thrombus is present or not and whether it is new or old.

Procedures

Anesthesia

Regional (supraclavicular) anesthesia infiltration was used for all patients. The patients received intravenous antibiotic just before skin incision [10].

Exploration and debridement

When the aneurysm was adjacent to the anastomosis, the AVF anastomosis was dissected first to control the arterial inflow. Proximal and distal controls were carried out.

Next, the arterialized vein was dissected with S-shaped incision or graded skin incisions were made up into healthy non-aneurysmal areas.

For patients with extensive erosion of the overlying thin skin due to repeated punctures, removal of excess skin as well as adherent vein walls and adjacent superficial tissue when required.

Preventive hemostasis (tourniquet) wasn't used. For anticoagulation, a heparinized sodium chloride solution was locally injected into the clamped veins (between 2,000 and 4,000 IU per operation). All vascular anastomoses and sutures were performed by using Polypropylene 6-0 or 5-0, according to the vein wall thickness [11].

Surgical reconstruction

(A) Aneurysmorrhaphy:

The proximal and distal non-aneurysmal outflow vein were clamped, then the aneurysmal venous wall was resected, and wall suturing (aneurysmorrhaphy) was performed with running suture 5/0. The entire part of the vein altered by the aneurysm was treated in such a way as to get the desired diameter, which should not be larger than 6 mm [10].

(B) Bypass graft:

A 6-mm PTFE graft was used, and this was looped subcutaneously in the lateral side of the arm. The proximal and distal ends of the vein were clamped, then an end-to-end anastomosis was carried out between the venous end and the graft using prolene 5/0 [12].

Postoperative Care and Follow-Up Examination

Patients were discharged on the following day.

Clinically, evaluation was assessed on the 1st, 3rd, and 6th postoperative months and consisted of a questionnaire, physical examination, and duplex ultrasound.

The questionnaire included the presence or absence of symptoms such as pain, limb edema, bleeding, and the efficacy of the HD sessions.

The physical examination was done to assess the presence of apparent ecchymosis, hematoma, edema, or signs of gross infection (redness, hotness, tenderness).

A duplex ultrasound was done for assessment of the patency of the AVF or the bypass graft and recurrence of aneurysmal dilatation. When thrombosed, the following parameters were recorded: fresh or old thrombus, the diameter and the flow of the fistula, and the presence of complications such as hematoma, signs of infection, thinning of the vessel wall (impending rupture).

The end point of the study

Occlusion, gross infection, rupture, or 6 months.

Results

This uncontrolled comparative clinical trial including 64 hemodialysis participants divided into two equal groups. Group A: Aneurysmorrhaphy (n=32), Group B: Bypass Graft (n=32).

Table 1. shows the basic characteristics of the participants, sixty-four hemodialysis patients in all, with a mean age of 39.8± 8.6 years Hypertension affected more than two-thirds of the participants. There was no significant difference between both groups regarding the fundamental traits.

Table 1. Basic characteristics of the participants.

Variable		Group A n=32	Group B n=32	Total N=64	P value
Age (years)	Mean ± SD	40± 9.6	39.5± 8.1	39.8± 8.6	0.912
	Median (Range)	43.5 (28, 51)	41.5 (25, 47)	43 (25, 51)	
Gender	Male, n (%)	8 (25)	20 (62.5)	28 (43.8)	0.315
	Female, n (%)	24 (75)	12 (37.5)	36 (56.3)	
Side	Left, n (%)	20 (62.5)	20 (62.5)	40 (62.5)	0.999
	Right, n (%)	12 (37.5)	12 (37.5)	6 (37.5)	
Dominancy	Left, n (%)	4 (12.5)	8 (25)	12 (18.8)	0.999
	Right, n (%)	28 (87.5)	24 (75)	52 (81.3)	
Chronic illness	HTN	24 (75)	20 (62.5)	44 (68.8)	0.999
	HTN and Diabetes	8 (25)	12 (37.5)	20 (31.3)	

Student t test, Fisher Exact test, *p is significant at <0.05

Table 2. shows the pre-operative max diameter between the two studied groups, it was 34.1± 3.8 mm among group A (aneurysmorrhaphy, while it was 45.1± 20.1 mm among group B (bypass graft). There was no significant variation in the pre-operative max diameter of the fistula between the two study groups (p= 0.151).

Table 2. Pre-operative max diameter of the fistula.

Variable		Group A n=32	Group B n=32	Total N=64	P value
Pre-operative max diameter (mm)	Mean ± SD	34.1± 3.8	45.1± 20.1	39.6± 15.1	0.151
	Median (Range)	34 (29, 40)	39 (28, 92)	35.5 (28, 92)	

Student t test, Fisher Exact test, *p is significant at <0.05

Table 3. shows the type of fistula, 62.5% of the participants of group A had BC AVF while only 37.5% had BB. All the patients of group B had BC AVF.

Table 4. shows the post-operative maximum diameter of the fistula, it was significantly higher among aneurysmorrhaphy compared to bypass graft one day, one month, and six months postoperative with a significant decrease in the diameter compared to the preoperative diameter of the fistula aneurysm of both study groups.

Table 5. shows no significant difference between aneurysmorrhaphy and bypass graft regarding one-day post-operative complications.

Table 3. Type of the fistula.					
Variable		Group A n=32	Group B n=32	Total N=64	P value
Type of fistula	BB, n (%)	12 (37.5)	0	12 (18.8)	0.200
	BC, n (%)	20 (62.5)	32 (100)	52 (81.3)	

Student t test, Fisher Exact test, *p is significant at <0.05

Table 4. Post-operative diameter of the fistula.					
Variable		Group A n=32	Group B n=32	Total N=64	P value
Post op Max diameter (1 day)	Mean ± SD	12.9± 3.4	6± 0	9.3±4.1	0.001*
	Median (Range)	12.3 (10.3, 20)	6 (6,6)	8 (6, 20)	
Post op Max diameter (1 month)	Mean ± SD	12.9± 3.4	6± 0	9.5± 4.3	0.001*
	Median (Range)	12.3 (10.3, 21)	6 (6, 6)	8.2 (6, 21)	
Post op Max diameter (6 months)	Mean ± SD	13.6± 3.5	6± 0	9.8± 4.6	0.001*
	Median (Range)	12.6 (10.5, 21)	6 (6, 6)	8.3 (6, 21)	

Mann-Whitney U test, Fisher Exact test, *p is significant at <0.05

Table 5. One-day post-operative complications.					
Variable		Group A n=32	Group B n=32	Total N=64	P value
Edema	Yes, n (%)	12 (37.5)	0	12 (18.7)	0.200
	No, n (%)	20 (62.5)	32 (100)	52 (81.3)	
Hematoma	Yes, n (%)	8 (25)	0	8 (12.5)	0.467
	No, n (%)	24 (75)	32 (100)	56 (87.5)	
Hemorrhage	Yes, n (%)	4 (12.5)	0	4 (6.3)	0.999
	No, n (%)	28 (87.5)	32 (100)	60 (93.8)	
Wound dehiscence	Yes, n (%)	0	0	0	0.999
	No, n (%)	32 (100)	32 (100)	64 (100)	
Thrombosis	Yes, n (%)	0	0	0	0.999
	No, n (%)	32 (100)	32 (100)	64 (100)	
Infection	Yes, n (%)	0	0	0	0.999
	No, n (%)	32 (100)	32 (100)	64 (100)	

Mann-Whitney U test, Fisher Exact test, *p is significant at <0.05

Table 6. shows no significant difference between aneurysmorrhaphy and bypass graft regarding one-month post-operative complications. Patency was 100% among aneurysmorrhaphy group (group A) vs 87.5% among the bypass graft group (group B) after one month postoperative.

Table 7. shows no significant difference between aneurysmorrhaphy and bypass graft regarding six-months post-operative complications. Patency was 100% among aneurysmorrhaphy group (group A) vs 75% among the bypass graft group (group B) after six months postoperative.

Table 6. One-month post-operative complications.					
Variable		Group A n=32	Group B n=32	Total N=64	P value
Edema	Yes, n (%)	4 (12.5)	0	4 (6.3)	0.999
	No, n (%)	28 (87.5)	32 (100)	60 (93.8)	
Hematoma	Yes, n (%)	4 (12.5)	0	4 (6.3)	0.999
	No, n (%)	28 (87.5)	32 (100)	60 (93.8)	
Hemorrhage	Yes, n (%)	0	0	0	0.999
	No, n (%)	32 (100)	32 (100)	64 (100)	
Wound dehiscence	Yes, n (%)	4 (12.5)	0	4 (6.3)	0.999
	No, n (%)	28 (87.5)	32 (100)	60 (93.8)	
Thrombosis	Yes, n (%)	0	4 (12.5)	4 (6.3)	0.999
	No, n (%)	32 (100)	28 (87.5)	60 (93.8)	
Infection	Yes, n (%)	4 (12.5)	4 (12.5)	8 (12.5)	0.999
	No, n (%)	28 (87.5)	28 (87.5)	56 (87.5)	

Mann-Whitney U test, Fisher Exact test, *p is significant at <0.05

Table 7. Six-month post-operative complications.					
Variable		Group A n=32	Group B n=32	Total N=64	P value
Edema	Yes, n (%)	0	0	0	0.999
	No, n (%)	32 (100)	32 (100)	64 (100)	
Hematoma	Yes, n (%)	0	0	0	0.999
	No, n (%)	32 (100)	32 (100)	64 (100)	
Hemorrhage	Yes, n (%)	0	0	0	0.999
	No, n (%)	32 (100)	32 (100)	64 (100)	
Wound dehiscence	Yes, n (%)	0	0	0	0.999
	No, n (%)	32 (100)	32 (100)	64 (100)	
Thrombosis	Yes, n (%)	0	8 (25)	8 (12.5)	0.467
	No, n (%)	32 (100)	24 (75)	56 (87.5)	
Infection	Yes, n (%)	0	8 (25)	8 (12.5)	0.467
	No, n (%)	32 (100)	24 (75)	56 (87.5)	

Mann-Whitney U test, Fisher Exact test, *p is significant at <0.05

Discussion

In ERSD patients, the permanent vascular access points are AVFs [13]. Consequently, AVF also has some complications in the long term [14].

The most serious complication of long-term use of AVFs is vascular access aneurysm, which in some cases may be fatal. Treating AVF complications is part of routine AVF care and maintenance. Upper extremity AVF venous aneurysms have been previously reported in up to 6% of patients [15].

This interventional study was conducted with the main objective to assess and compare the outcomes of aneurysmorrhaphy vs surgical exclusion of the aneurysm by bypass graft in terms of intra and post-operative complications and the patency rates during AVF aneurysm management in HD patients.

This study analyzed data from a total of 64 hemodialysis patients. They had a median age of 43 years whereas female prevalence of 56.3%. Sixty-two and half percent of people had a left-sided disorder, while 81.3% had a right-sided dominant disorder. Hypertension affected more than two-thirds of the patients. There was no significant variation in the fundamental traits between the study groups.

The flow rate in our study was 1820± 974.4 ml/ min and 935.5± 510.5 ml/ min among group A (aneurysmorrhaphy) and B (bypass graft) respectively. It also showed no significant difference in the flow rate at the two study groups (p= 0.054).The preoperative max diameter in our study was 34.1± 3.8 mm among group A (aneurysmorrhaphy, while it was 45.1± 20.1 mm among group B (bypass graft).

Similar results were obtained from Wan et al. [17], The mean pre-operative access diameter was 44.0 mm± 5.1 mm and blood flow was 1618.2± 277.0 ml. In Vo et al., (2015) study [16], the mean aneurysm diameter was 45 mm. The mean flow rate was1712± 758 mL/min. The median age of AVFs was 63 months at the time of repair. By comparison, they had similar starting points.

Post operative maximum diameter was significantly higher among aneurysmorrhaphy compared to bypass graft as the synthetic graft used in our study was 6 mm in diameter.

In our study, Aneurysmorrhaphy showed excellent patency outcomes and post operative maximum diameter, but bypass graft showed inferior patency and higher incidence of infection.

Similar to Nezakatgoo et al. [22], post operative complications were the occurrence of steal syndrome (6.9%), stenosis (2.9%), thrombosis (4.9%), and infection (2.0%).

Our study found that patency was 100% vs 87.5% after one month postoperative and 100% vs 75% six months post-operative among aneurysmorrhaphy and bypass graft respectively.

In the same line, a study by Hejna et al. [23] agreed that secondary patency after a follow-up period of 1 years revealed a patency rate of 83.3% and 70.5% among aneurysms treated with aneurysmorrhaphy and graft respectively. In the same line with our results, Wan et al. [17] agreed that the rates of primary patency at 6 months were 100% and at 12 months were 95%.

In the meta-analysis by Baláž et al. [24], they reviewed 13 studies from 1973 to 2019, analyzing nearly 600 patients who underwent aneurysm repair for primary AVFA repair, and agreed that the pooled primary patency rate at 12 months was 82% (95% CI 69% –90%, $p < 0.01$). The primary functional patency rate at 95 months after aneurysmorrhaphy was 90.2% in Nezakatgoo et al [22].

Almerey et al [19] reviewed 19 articles and identified 675 patients who underwent surgical repair of AVFA between 2010 and 2017, but this study was based on surgical repair methods patency. After long-term observation for at least 6 months, the patency rate of fistulas ranged from 47% to 100%. The patency rates at 3, 6, 12, and 24 months after aneurysmorrhaphy were 89.5%, 81.6%, 71%, and 63.1%, respectively. Aneurysmorrhaphy appeared to be the best conservative surgical treatment for aneurysmal complications of AVFs [25].

In the study by Chang J et al [12], patients who underwent graft repair had a 3.5 times probability of losing primary paten-

cy within 1 year compared with the aneurysmorrhaphy group (p = 0.025). Patients who underwent graft repair were 6.7 times more likely to develop an infection than those who underwent aneurysm repair (p = 0.014).

Conclusion

Aneurysmorrhaphy showed higher patency outcomes, post-operative maximum diameter, and thrombosis. Bypass graft showed a higher incidence of infection.

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