Different Modalities for Management of Thrombosed Arteriovenous Fistula: Multicenter Experience

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Introduction: This study aims to report and evaluate different declotting modalities with their outcomes for salvage of thrombosed native dialysis access.

Patients and methods: Between March 2023 to March 2024, 70 patients with first time thrombosed native arteriovenous fistula (AVF) were recruited, 27 radio-cephalic, 20 brachio-cephalic and 23 brachio-basilic AVFs were treated either surgically with thrombectomy or endovascularly using different endovascular declotting concepts. Patients had follow-up at 1 week, 1, 3 and 6 months postoperatively.

Results: In our study 15.7% (n=11/70) were treated with open thrombectomy and 84.3% (59/70) were treated endovascularly using 5 different techniques. Techniques used were open surgical thrombectomy, balloon maceration, pulse spray thrombolysis, mechanical thrombectomy (Aspirex device), aspiration thrombectomy (Penumbra device) and rheolytic mechanical thrombectomy (Angiojet device). Clinical success achieved in each group was 72.7%, 70%, 69.2%, 100%, 100% and 90.9% respectively (p=0.175), with 6-month primary patency 72.7%, 60%, 69.2%, 75%, 77.8% and 86.4%, respectively (p=0.629).

Conclusions: Surgical and endovascular intervention for thrombosed AVFs have comparable early clinical success and short-term primary and secondary patency rates.

Key words: Thrombosed fistula, native, thrombectomy, declotting access.

Introduction

A functional hemodialysis vascular access is the one with adequate blood flow through dialysis access circuit allowing adequate hemodialysis and prevent access thrombosis. It is the lifeline for patients with end-stage kidney disease (ESRD) and is considered a major determinant of survival and quality of life in this patient population.[1]

Arteriovenous (AV) access thrombosis remains a major threat to this crucial lifeline that may result in a considerable morbidity for patients receiving maintenance hemodialysis for ESRD. Patients with AV access thrombosis often present as an emergency because of missed dialysis and may require hospital admissions and placement of temporary hemodialysis catheters to perform lifesaving dialysis.[2]

The main concepts of thrombectomy are based on removing the thrombus, regaining patency of the thrombosed access and treating the underlying culprit vascular stenotic lesion aiming to achieve access salvage with prolonged patency rate.[3] For salvaging a thrombosed arteriovenous fistula (AVF), a variety of surgical techniques have been described, ranging from open surgical thrombectomy to percutaneous thrombus removal methods including pharmacological thrombolysis, balloon-assisted thrombus maceration, aspiration, mechanical thrombectomy, or a combination of these techniques can be considered.[4]

As the outcomes of surgical and endovascular declotting modalities for thrombosed vascular access are comparable, there is no consensus whether AV access thrombosis is best treated by surgical or endovascular intervention.[5] Although the guidelines concerned with management of dialysis access highlights the importance of early thrombus removal and simultaneous treatment of the underlying lesion in thrombosed AVFs, they offer no preference for surgical or endovascular intervention regarding AV grafts or AVFs.[6] Pharmaco-lytic, pharmaco-mechanical and mechanical thrombus removal therapies showed promising outcomes, resulting in many centers adopting an endovascular-first approach.[7]

This retrospective multicentric study from three tertiary hospitals, aimed at evaluating the clinical outcomes of open surgical thrombectomy and endovascular salvage techniques of clotted arteriovenous (AV) accesses and to identify factors associated with favourable treatment outcomes.

Patients and methods

Study characteristics

We conducted our retrospective review of prospectively collected data after approval of our institutes ethical committee. Data of 110 patients who presented with first time thrombosed, non-functioning upper extremity dialysis access native AVF during the period between March 2023 to March 2024 was collected from the registry and

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archives of vascular surgery departments at Ain Shams University Hospitals, Benha University Hospital and Police Academy Hospital. All patients were successfully treated regaining the patency of thrombosed dialysis access. Only 70/110 patients fulfilled our inclusion criteria.

We recruited patients aged from 18-70 from both genders, who were maintained on long term regular dialysis, their fistulae were mature and functioning efficiently before thrombosis, patients presented within 3 weeks since fistula became thrombosed, and those with controlled blood pressure.

On the other side those with recent access creation or previous access intervention, known cardiac patients (Heart failure patients) or patients with central venous occlusion (Venous outflow obstruction), patients with large access aneurysmal degeneration, patients with infected access and patients with upper limb deep venous system thrombosis or with coagulopathy were excluded.

We analyzed the demographic data, medical history and history of previous vascular access or previous central venous catheters, and data about last dialysis session. General and local examination of fistula to ensure its thrombosis (Loss of thrill and bruit), examination of upper limb arterial system for any disorder (Occlusion - significant stenosis -aneurysms). Data from Upper limb arteriovenous duplex was revised to exclude arterial disease, and confirm occlusion of the fistula, and determine the occluded segment. Laboratory investigations: CBC, Bleeding profile, Na, K, BUN, creatinine, and viral markers were checked in all patients.

Surgical technique

All procedures were performed under either local anesthesia with/without sedation, regional anesthesia (Supraclavicular nerve block). Thrombosis of the fistula and patency of the inflow artery were confirmed by intraoperative duplex ultrasound. Interventions were classified into: Surgical thrombectomy, Endovascular balloon maceration, Pulse spray thrombolysis, Aspiration mechanical thrombectomy by Penumbra and Aspirex catheters and mechanical rheolytic thrombectomy by Solent Omni AngioJet catheter.

The decision to perform any of these procedures was individualized by patient comorbidities, logistics availability, insurance coverage and based on the discretion of the attending surgeon. Adjunctive balloon angioplasty was done to treat culprit lesions at the inflow artery, the anastomosis, outflow vein or central veins accordingly.

Open surgical thrombectomy

Patients who had open surgical thrombectomy were operated upon within 24 hours of presentation. An approximately 2 to 3 cm transverse skin incision was made over fistulated vein. A transverse venotomy was made and the thrombus was removed using a Fogarty balloon catheter in antegrade and retrograde fashion to restore inflow and outflow. Extensive clot burden in ectatic fistulas was managed by manual squeezing "Milking".

All procedures were performed under fluoroscopic monitoring in hybrid operative theater equipped with C-arm fluoroscopy device, using a 4- to 6-Fr Fogarty embolectomy catheter (LeMaitre Vascular Inc, Burlington, MA, USA, Edwards Life sciences LLC., Irvine, CA, USA). A 6-8-F introducer was introduced via distal fistulotomy opening and a fistulogram was taken to confirm adequate thrombectomy and to identify any underlying stenosis, any needed adjunctive procedure to treat the underlying culprit lesion was done according to angiographic finding.

Balloon angioplasty using 6-12 mm noncompliant balloon (Mustang, Boston Scientific, Marlborough, MA, USA, Conquest, Bard Peripheral Vascular Inc, Tempe, AZ, USA, Dorado, Bard Peripheral Vascular Inc, Tempe, AZ, USA) was our strategy to correct luminal stenosis of vessels. Postangioplasty completion angiography was done in two different radiological exposure evaluating the technical success and exclude possible residual hemodynamically significant stenosis. The procedure was terminated with sheath removal followed by repairing the venotomy with 6-0 polypropylene sutures.

Endovascular thrombectomy techniques

All endovascular procedures were performed under local anaesthesia either in Cath lab or in a hybrid operative room, equipped with a fixed C-arm fluoroscopy device. A duplex guided access was used to puncture the target vessel access chosen according to the anatomical site of the treated AVF, both antegrade and retrograde vascular access to the venous segment of the AVF was performed, an introducer sheath 5-7 F was inserted, and initial diagnostic angiogram was done. In this group, 3 different endovascular declotting concepts were used, as follows.

Method 1: Balloon maceration technique

Angioplasty balloon was inserted into the thrombosed venous segment and was inflated to compress the clot against the wall of the native vein. We repeated balloon inflation until blood flow was restored to the fistula. We found this method was effective when performed soon after thrombosis onset and for a small segmental thrombus burden localized to one segment of the fistula **(Fig. 1)**. In some cases, with long segment thrombosis, 5-6 Fr. catheter was used to aspirate thrombus.

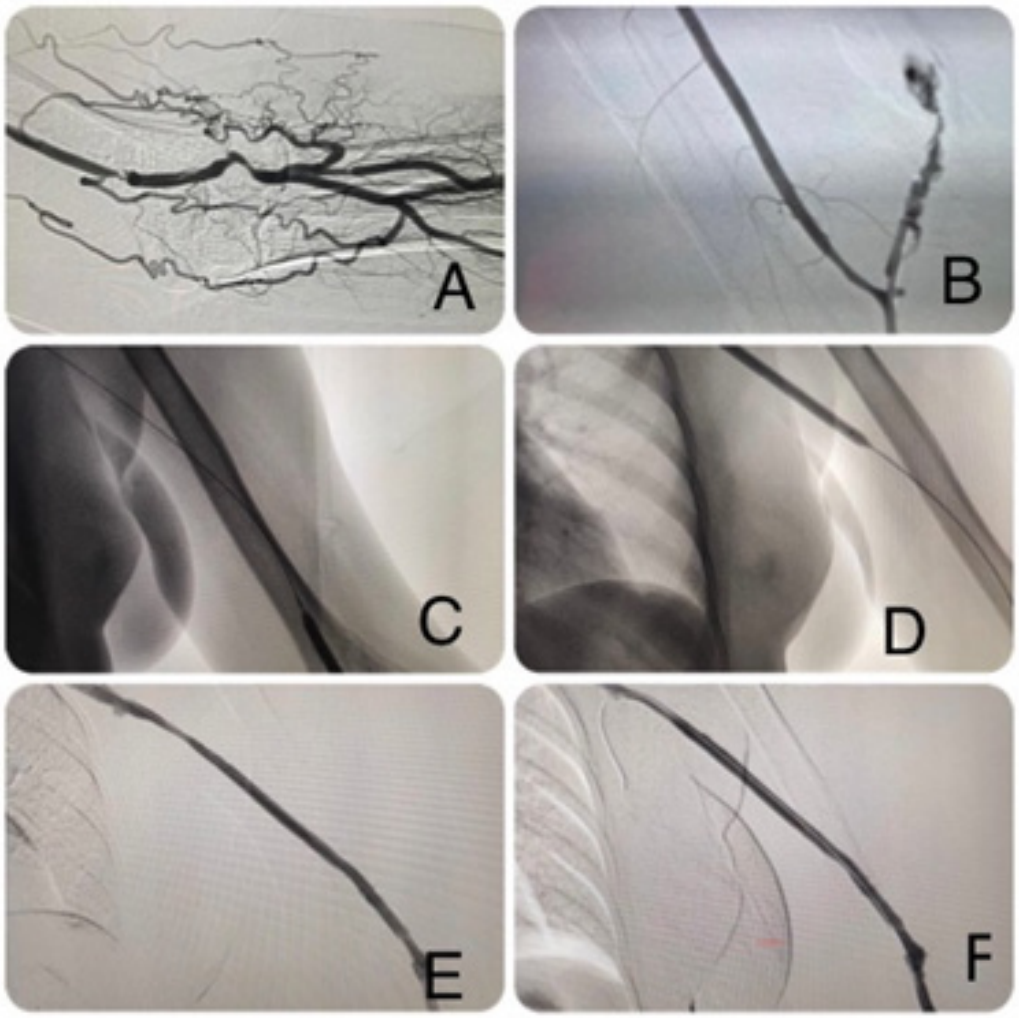

Fig 1: A,B) Thrombosed BC-AVF C,D) Balloon maceration of occluding thrombus E,F) Post-angioplasty completion angiogram with regaining patency of BC-AVF.

Method 2: Pulse spray thrombolysis technique

After gaining access to thrombosed fistula, a thrombolytic drug recombinant tissue plasminogen activator [rt-PA], (Actilyse; Boehringer-Ingelheim, Ingelheim am Rhein, Germany) was sprayed directly into the clot within the thrombosed segment with small (0.5 cc) forceful aliquots. Overlapping TPA injection was done as the catheter was intermittently retracted to the sheath, we used 4-Fr Fountain infusion system with an appropriate-length catheter 135 cm with infusion segment 20 cm was inserted (Merit Medical System Inc., South Jordan, UT, USA). Patients will wait from 20 minutes up to 60 minutes according to thrombus load prior to additional adjunctive interventions for treating the underlying pathology.

Method 3: Mechanical thrombectomy technique

We utilized 3 different mechanical thrombectomy devices in our study. Aspirex mechanical thrombectomy catheter (Straub, Wangs, Switzerland), Penumbra Indigo system (Penumbra, Inc, Alameda, CA, USA) and AngioJet (Solent Omni) Rheolytic Thrombectomy System (Boston Scientific Corporation, Minneapolis, MN, USA), were utilized to generate mechanical force dissolving the thrombus and aspirate clot fragments into a catheter.

For all methods, angiography was performed after declotting of thrombosed access to check for residual thrombus and to reveal any underlying stenotic lesions of the inflow arteries, the fistula and the outflow veins. An adjunctive procedure (bare balloon angioplasty) was done according to angiographic finding to correct luminal stenosis **(Fig. 2)**. If residual thrombus was found, repetition of the same thrombectomy technique could be done to ensure adequate thrombus removal. Completion angiogram was performed to confirm the patency of the fistula and anastomosis.

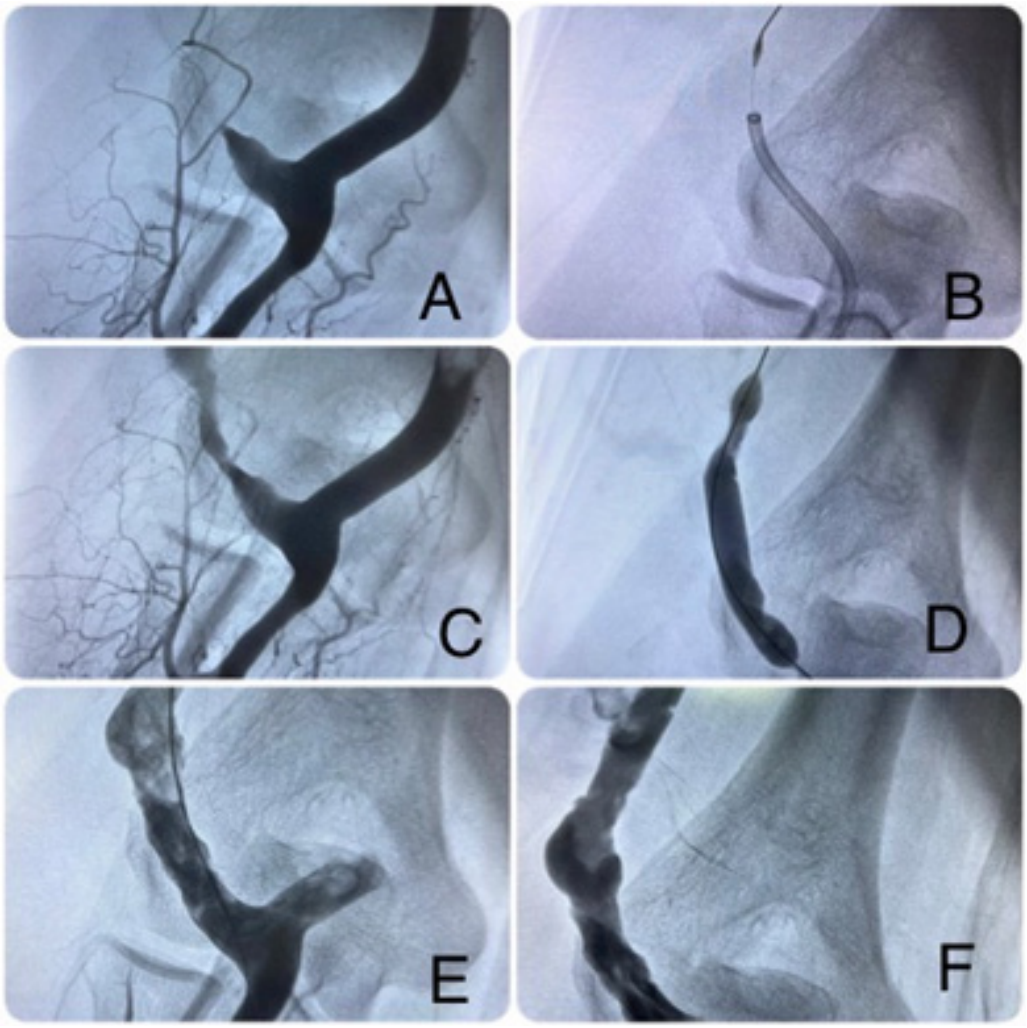

Fig 2: A) Thrombosed brachiocephalic (BC) AVF. B) Penumbra catheter at site of thrombosis. C) Juxta-anastomotic culprit lesion revealed after aspiration of thrombus. D) Balloon angioplasty with significant waist. E,F) completion angiogram with regaining patency of BC-AVF.

Post procedure medications: All patients were prescribed LMW heparin in prophylactic dose 40 IU/24hrs for one week then shifted to apixaban 2.5 mg twice daily for 3 months, the declotted accesses were allowed to be used for dialysis after one week.

Follow up: Patients had been followed-up at 1 week, 1, 3 and 6 months postoperatively. Patency of the fistula was assessed clinically, and duplex was done if there was any suspicion of restenosis or thrombosis.

Endpoints

Primary endpoints: Clinical and technical success, Primary, Assisted primary and cumulative patency at 1 week, 1, 3 and 6 months.

Primary patency: A duration of time measuring intra-access patency that starts from the date of index procedure (Surgical or Endovascular thrombectomy) to the date of one of the following events (Whichever one comes first): thrombosis or any intervention to facilitate, maintain, or re-establish patency.

Cumulative patency: A duration of time measuring intra-access patency that starts from the date of index procedure to the date of vascular access abandonment.

Technical success: Palpable thrill or, at least an audible bruit overlying the anastomosis or over the vein close to the anastomosis.

Clinical success: The ability of the access to provide prescribed dialysis consistently with 2 needles for more than two thirds of the dialysis sessions within 4 consecutive weeks.

Secondary endpoints: Procedure related complications and mortality.

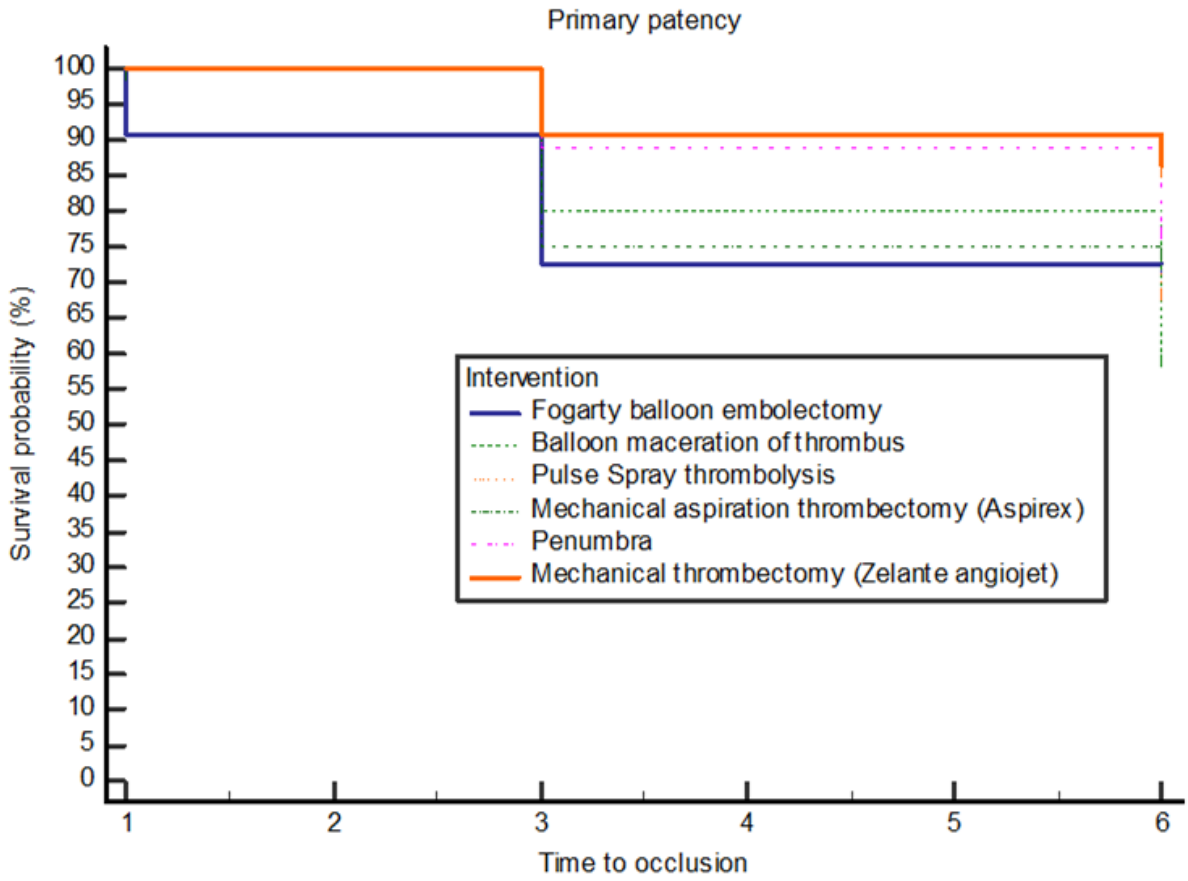

Fig 3: KM curve showing primary patency along the follow up period.

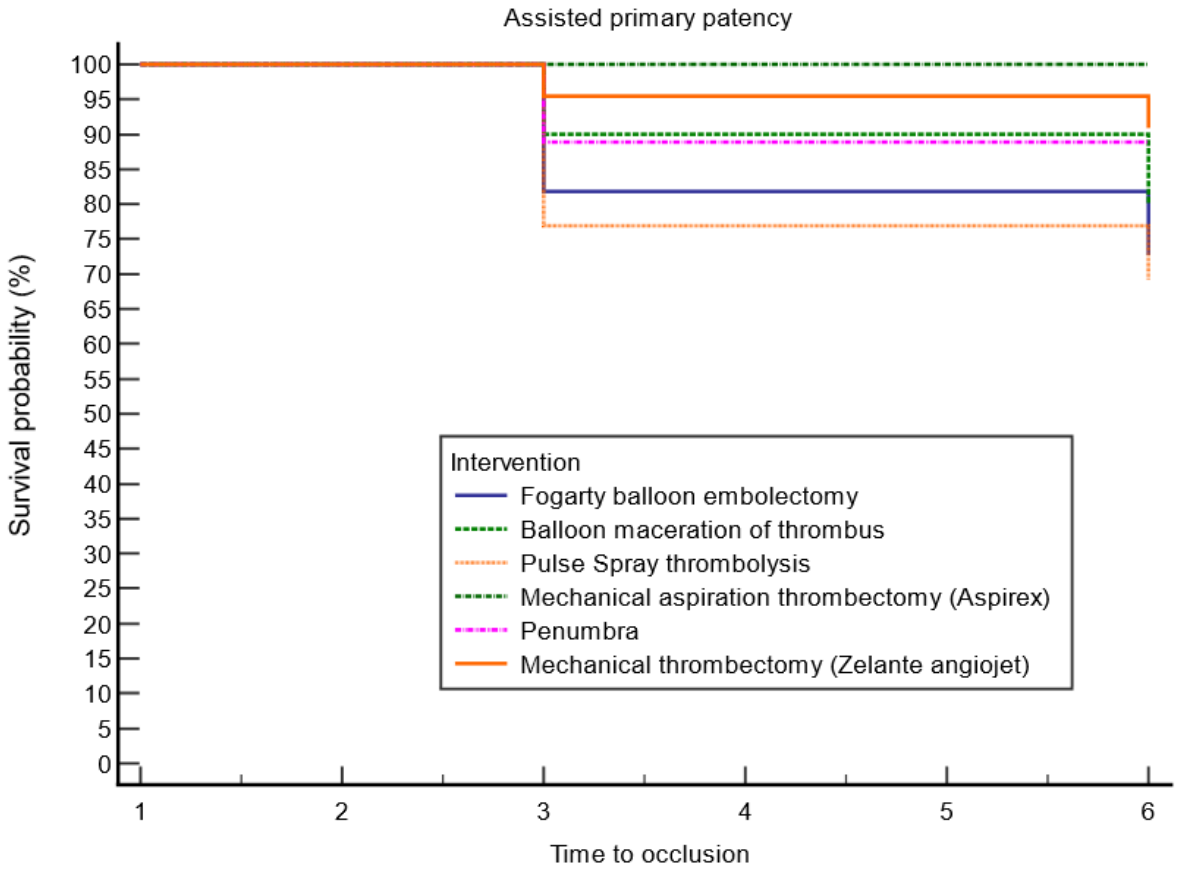

Fig 4: KM curve showing assisted primary patency along the follow up period.

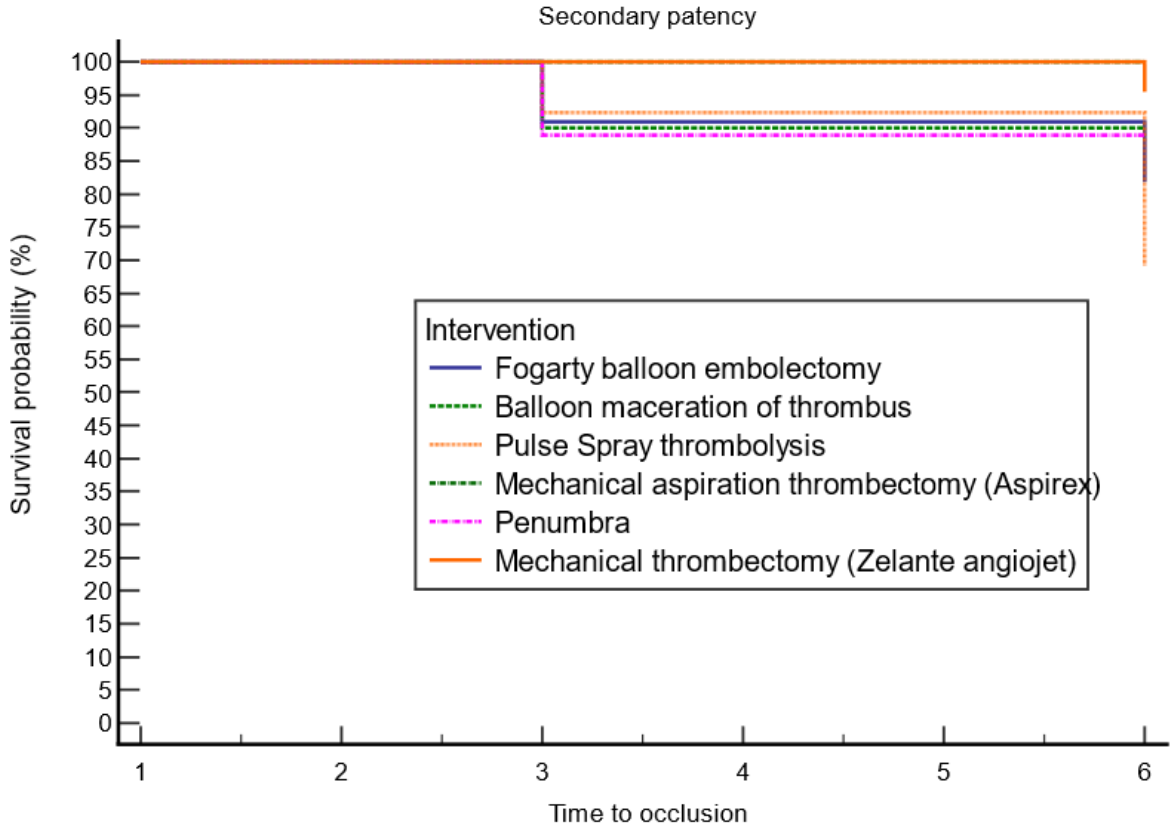

Fig 5: KM curve showing cumulative (Secondary) patency along the follow up period.

Statistical analysis: SPSS version 27 was used for statistical analysis. Descriptive statistics (Mean, Standard deviation (±SD) and range for parametric numerical data. Analytical statistics (Fisher's exact test was used to examine the relationship between two qualitative variables when the expected count is less than 5 in more than 20% of cells. Kaplan-Meier Survival Analysis: was used to estimate median primary patency, assisted primary patency and cumulative secondary patency. Log rank test to compare time-to-event variables by levels of a factor variable).

Results

This study included 70 patients with acutely and subacutely thrombosed different patterns of upper extremity AVF, Demographic data are shown in **Table 1**.

There were 27 radio-cephalic, 20 brachio-cephalic and 23 brachio-basilic AVFs. 24 patients presented within 1 week of fistula thrombosis, while 46 patients presented within 1 to 3 weeks.

Surgical thrombectomy was offered to 15.7% of included patients (n=11/70), 72.7% (n=8/11) of surgical thrombectomy group were operated upon under local anesthesia, while endovascular declotting was done in 84.3% (n=59/70) using different accesses for achieving fistulae recanalization **(Table 2)**, all endovascular procedures were done under local anesthesia.

Balloon maceration was used in 16.9% (n=10/59), pulse spray thrombolysis was used in 22% (n=13/59), mechanical thrombectomy using Aspirex catheter was done in 8.5% (n=5/59), Penumbra aspiration thrombectomy catheter was used in 15.3% (n=9/59) and access declotting using rheolytic mechanical thrombectomy AngioJet catheter was used in 37.3% (22/59).

Adjunctive balloon angioplasty for treating underlying culprit lesion was done in 65.7% (n=46/70), in open surgically treated patients, adjunctive angioplasty was done in 63.6% (n=7/11) while in endovascular based intervention group it was done in 67.8% (n=40/59). Angioplasty was done using plain balloons. No drug coated balloons (DCB) nor drug eluting stents (DES) were used.

The overall technical success of different modalities was 97.1% and the clinical success in regaining access function was 82.9%. There was no statistically significant difference between the different modalities as regards the technical and

clinical success **(Table 3).**

The primary access patency during scheduled follow-up visits was illustrated in **figs. 3-5.** The 6-month primary patency was 72.7% in Fogarty balloon thrombectomy group, 60% in balloon maceration technique group, 69.2% in pulse spray thrombolysis group, 75% in Aspirex mechanical thrombectomy group, 77.8% in Penumbra aspiration catheter group and 86.4% in AngioJet Solent Omni group respectively (p=0.629). The 6-month assisted primary patency was 72.7%, 80%, 69.2%, 100%, 88.9% and 90.9% respectively (p=0.520), the 6-month secondary patency rate was 81.8%, 90%, 69.2%, 100%, 88.9% and 95.5% respectively (p=0.330) **(Table 4)**.

The overall complication rate was 18.6%. Access site bleeding was the most common occurred in 12.9% (n=9/70). Infection was related to surgical thrombectomy group, it was 2.9% (n=2/70). Access vessel thrombosis was 1.4% (n=1/70) and pulmonary embolism was 1.4% (n=1/70). There was no significant difference between groups for procedure-related complications. In our study there was no procedure related mortality **(Table 3)**.

Table 1: Demographic data

		Mean±SD	Range
Age		50.4±15.5	18-78
		N	%
Gender	Male	35	50.0%
	Female	35	50.0%
Smoking	No	37	52.9%
	Yes	33	47.1%
DM	No	29	41.4%
	Yes	41	58.6%
HTN	No	29	41.4%
	Yes	41	58.6%
IHD	No	38	54.3%
	Yes	32	45.7%

Table 2: Access site for intervention

Access for intervention		**N**	**%**
Radial	No	65	92.9%
	Yes	5	7.1%
Trans brachial	No	64	91.4%
	Yes	6	8.6%
Antegrade vein	No	15	21.4%
	Yes	55	78.6%
Retrograde vein	No	21	30.0%
	Yes	49	70.0%

Table 3: Technical and clinical success, and complication of each modality

		Fogarty balloon thrombectomy		Balloon maceration of thrombus		Pulse Spray thrombolysis		Mechanical aspiration thrombectomy (Aspirex)		Penumbra		Mechanical thrombectomy (Solent Omni)	Fisher exact test	
		%	N	%	N	%	N	%	N	%	N	%	p value	sig.
Technical success	No	1	9.1%	0	0.0%	1	7.7%	0	0.0%	0	0.0%	0	0.0%	0.513 NS
	Yes	10	90.9%	10	100.0%	12	92.3%	5	100.0%	9	100.0%	22	100.0%	
Clinical success	No	3	27.3%	3	30.0%	4	30.8%	0	0.0%	0	0.0%	2	9.1%	0.175 NS
	yes	8	72.7%	7	70.0%	9	69.2%	5	100.0%	9	100.0%	20	90.9%	
Limb ischemia	No	11	100.0%	10	100.0%	13	100.0%	5	100.0%	9	100.0%	22	100.0%	NA
	yes	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
PE	No	11	100.0%	9	90.0%	13	100.0%	5	100.0%	9	100.0%	22	100.0%	0.343 NS
	yes	0	0.0%	1	10.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
Access site bleeding	No	9	81.8%	9	90.0%	11	84.6%	5	100.0%	8	88.9%	19	86.4%	1.000 NS
	yes	2	18.2%	1	10.0%	2	15.4%	0	0.0%	1	11.1%	3	13.6%	
Remote bleeding	No	11	100.0%	10	100.0%	13	100.0%	5	100.0%	9	100.0%	22	100.0%	NA
	yes	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
Infection	No	10	90.9%	10	100.0%	13	100.0%	5	100.0%	9	100.0%	21	95.5%	0.882 NS
	yes	1	9.1%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	4.5%	
Access vessel thrombosis	No	11	100.0%	9	90.0%	13	100.0%	5	100.0%	9	100.0%	22	100.0%	0.343 NS
	yes	0	0.0%	1	10.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
Procedure related mortality	No	11	100.0%	10	100.0%	13	100.0%	5	100.0%	9	100.0%	22	100.0%	NA
	yes	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	

Table 4: Patency along the follow up period

		Fogarty balloon thrombectomy		Balloon maceration of thrombus		Pulse Spray thrombolysis		Mechanical aspiration thrombectomy (Aspirex)		Penumbra		Mechanical thrombectomy (Solent Omni)	Fisher exact test	
		%	N	%	N	%	N	%	N	%	N	%	p value	sig.
Primary Patency	1 m	10	90.9%	10	100.0%	13	100.0%	5	100.0%	9	100.0%	22	100.0%	0.500 NS
	3 ms	8	72.7%	8	80.0%	10	76.9%	3	75.0%	8	88.9%	20	90.9%	0.686 NS
	6 ms	8	72.7%	6	60.0%	9	69.2%	3	75.0%	7	77.8%	19	86.4%	0.629 NS
Primary assisted Patency	1 m	11	100.0%	10	100.0%	13	100.0%	5	100.0%	9	100.0%	22	100.0%	NA
	3 ms	9	81.8%	9	90.0%	10	76.9%	4	100.0%	8	88.9%	21	95.5%	0.588 NS
	6 ms	8	72.7%	8	80.0%	9	69.2%	4	100.0%	8	88.9%	20	90.9%	0.520 NS
Secondary Patency	1 m	11	100.0%	10	100.0%	13	100.0%	5	100.0%	9	100.0%	22	100.0%	NA
	3 ms	10	90.9%	9	90.0%	12	92.3%	4	100.0%	8	88.9%	22	100.0%	0.517 NS
	6 ms	9	81.8%	9	90.0%	9	69.2%	4	100.0%	8	88.9%	21	95.5%	0.330 NS

Discussion

AVF is the preferred permanent vascular access and considered the lifeline for most hemodialysis patients. Thrombosis is the most common complication of AVF and should be considered a potential emergent condition depending upon patient clinical condition.

The strategy of whether to use surgical or endovascular techniques for this purpose remains controversial. In comparison to AVG, the incidence of thrombotic occlusion of autogenous AVF is considerably lower. That is why, less attention has been paid to the management of thrombosed fistulae. Since 2000, an increasing number of publications on open surgical and endovascular treatment options have appeared in the literature.6

Due to multiple pathological and anatomical features, the de-clotting of thrombosed AVF can pose a wider range of technical difficulties than those experienced with PTFE grafts. These difficulties include thin, mobile vein walls that is difficult to palpate, deceptive patent side collaterals, variable site of venous stenoses that occurs anywhere from the feeding artery to the central veins, an irregular anatomy that makes it frequently impossible to localize the anastomosis clinically, segmental aneurysmal dilatation containing thick layers of old wall-adherent thrombi and high thrombus load. However, even in the presence of these features, several articles have reported de-clotting success rates of 76 to 100% using thrombo-aspiration and 89% while using mechanical devices.[8]

This is a retrospective study including hemodialysis patients who presented in the period from March 2023 to March 2024 with thrombosed native AVF and had thrombectomy to regain fistula patency. Six different modalities were used: Open surgical thrombectomy using Fogarty catheter, percutaneous balloon maceration of the thrombus, pulse spray thrombolysis, mechanical aspiration thrombectomy using Aspirex device and Penumbra catheter, and mechanical rheolytic thrombectomy with AngioJet Solent Omni device.

There was no significant difference between patients' demographics among the 6 groups. In our study the cause of access thrombosis was juxta-anastomotic segment in 32.9% (n=23/70), draining vein puncture site stenosis 50% (n=35/70), cephalic arch & proximal basilic vein in 25,7% (n=18/70), and central veins stenosis in 12.9% (n=9/70). 50% of studied patients (n=35/70) had multiple tandem culprit lesions.

In Jong Hee Hyun, et al. study, the primary culprit lesion pattern was comparable to our study it was at juxta-anastomosis in 40.7% (n=24/59), at draining vein in 50.8% (n=30/59), and at central vein in 8.5% (n=5/59). 71.2% of AVFs (n=42/59) had multiple stenotic lesions.[9]

Our experience shows that excellent technical and clinical success rates could be achieved in treating non-functioning autogenous AVF due to thrombosis. Technical success was 90.9% in Fogarty balloon thrombectomy, 100% in thrombus balloon maceration technique, 92.3% in pulse spray thrombolysis and 100% in patients treated with Aspirex thrombectomy catheter, Penumbra thrombectomy device and AngioJet Solent Omni rheolytic thrombectomy catheter.

Restoring access function was achieved in 72.7% of patients in surgical thrombectomy group, 70% in balloon maceration thrombectomy group, 69.2% in pulse spray thrombolysis group, 90.9% in rheolytic mechanical thrombectomy group and 100% in aspiration mechanical thrombectomy.

Drouven et al. reported their results regarding use of AngioJet mechanical thrombectomy of thrombosed both AVF and AVG, the technical success rate was 92.6% of AVF cases and 92.0% of AVG cases, while Clinical success was achieved in 92.6% of AVF cases and 90.8% of AVG cases.[10]

Experience and comparison of different endovascular thrombectomy devices used for treating thrombosed AVF was described by Yang et al., the AngioJet rheolytic mechanical thrombectomy device was compared with the Arrow-Trerotola percutaneous thrombectomy device (PTD) in 275 thrombectomy procedures in patients with thrombosed AVF. They concluded that the PTD had a significantly higher success rate 91% compared to the AngioJet 76%.[11]

In our study, the 6-month primary patency was 72.7% and the 6-month secondary patency was 81.8% in open surgical thrombectomy group versus 74.6% and 86.4% respectively in endovascular based therapy group. The 6-month primary patency of different endovascular modalities was 60% in balloon maceration technique group, 69.2% in pulse spray thrombolysis group, 75% in Aspirex mechanical thrombectomy group, 77.8% in Penumbra aspiration catheter group and 86.4% in AngioJet Solent Omni group respectively, while the 6-month secondary patency rate was 90%, 69.2%, 100%, 88.9% and 95.5% respectively.

Endovascular mechanical thrombectomy using Aspirex device and AngioJet Solent Omni had the highest cumulative patency along the follow up period. While the lowest cumulative patency was observed in the open surgical embolectomy group. However, these results are statistically nonsignificant, most probably due to the low number of patients. Jong Hee Hyun reported that, the primary patency rate of salvaged AVFs was significantly better in the hybrid surgery group than in the percutaneous mechanical thrombectomy group (Log-rank test, $P<0.001$). Primary patency in hybrid surgery group was 85.9% and 81.1% at 6 months and 12

months, respectively. Primary patency of salvaged AVF by percutaneous mechanical thrombectomy was 36.8% and 26.3% at 6 months and 12 months respectively.[9]

Cho et al. used pulse-spray pharmacomechanical thrombolysis as the primary mode of therapy for the percutaneous treatment of thrombosed native AVF. A technical success rate of 75% was achieved with primary and secondary patency rates of 64% and 71% at six months and 55% and 63% at 12 months, respectively.[12]

Aydın et al. reported in his study, the success rate and patency outcomes of pharmacomechanical thrombectomy using the AngioJet rheolytic system versus open surgical thrombectomy. The 6-month primary patency rate was significantly higher in the pharmacomechanical treatment group compared to the surgical thrombectomy group (85% vs. 67%, respectively; $p<0.05$) with significantly higher rates at 12 months (78% vs. 55%, respectively; $p<0.05$), the primary failure rate was higher in the surgical group 28%, compared to the pharmacomechanical group 10%, although it did not reach statistical significance ($p=0.18$).[13] In Aydın et al. study, they were unable to perform fistulogram during surgical procedures and were unable to identify and treat more proximal and central vein problems, therefore, this might have adversely affected their results in surgical thrombectomy patient group.

Our results suggest that endovascular treatment of thrombosed AVF is safe and at least as effective as surgical treatment regarding technical success and patencies.

Limitations

Our study has some limitations. First, the retrospective design of the study suggests the potential for missing or incomplete data However, the interventions and complications were documented in real-time, making us confident in the data accuracy. Second, all included centers are tertiary referral hospitals that often receive complex cases. As such, our outcomes may not be generalizable to other hospitals. Third, our overall study population was relatively small, and we had a small number of patients in the surgical thrombectomy group. Fourth we had no selection criteria for both surgical and endovascular thrombectomy procedures, and the included patients were not randomized, decision-making process for the treatment procedure was based on the surgeon discretion and logistics availability. Lastly, financial costs were not included in our study which may affect the popularity of some high-cost techniques.

These factors suggest the possibility that our study may have lacked the statistical power to identify all significant difference and associations between studied groups. Future randomized controlled studies are recommended to determine the advantage of endovascular therapy over open surgical thrombectomy in patients with thrombosed AVF.

Conclusion

Thrombosis is one of the most common complications of AVF and can be treated by surgical thrombectomy or endovascular methods using pharmacomechanical thrombectomy systems. The outcome of this study suggests that both open surgical thrombectomy and endovascular declotting of thrombosed autogenous AVF utilizing different modalities are successful in regaining vascular access patency and resuming hemodialysis function.

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