



Original Article

Percutaneous intervention for symptomatic central vein stenosis in patients with upper limb arteriovenous dialysis access



Ashwal Aj*, Abdul Razak UK, Padmakumar R, Umesh Pai, Sudhakar M

Department of Cardiology, Kasturba Medical College, Manipal Academy of Higher Education, Manipal, India, India

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ABSTRACT

Central venous stenosis is an important hindrance to long-term maintenance of arteriovenous access in the upper extremities in dialysis patients.

Aim: The present study was done to determine feasibility and clinical success of endovascular approach for the treatment of symptomatic central venous stenosis associated with significant ipsilateral limb edema in dialysis patients with vascular access in the upper limb.

Methods: A database of hemodialysis patients who underwent endovascular treatment for central venous stenosis from January 2014 to January 2017 at our institute was retrospectively reviewed. Follow-up was variable.

Results: The study included ten patients (6 men and 4 women) with a mean age of 45.2 years, who underwent thirteen interventions during a period of 3 years. The technical success rate for endovascular treatment was 100%. One patient underwent primary PTA (percutaneous transluminal angioplasty). Seven patients underwent primary PTA and stenting. Three patients underwent secondary PTA. One among these patients underwent secondary PTA twice along with fistuloplasty. One patient underwent secondary PTA with stenting. No immediate complications were encountered during the procedure. Our study shows a primary patency rate of 67% and 33% at 6 months and 12 months for PTA with stenting. Our study also shows secondary or assisted primary patency of 75% at 6 months of follow-up.

Conclusions: Endovascular therapy (PTA) with or without stenting for central venous stenosis is safe, with low rates of technical failure. Multiple additional interventions are the rule and long-term patency rate is not very good.

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1. Introduction

Central venous stenosis usually occurs as a complication of central venous catheterization and significantly complicates dialysis through arteriovenous grafts/fistula in the ipsilateral limb. If a functioning arteriovenous fistula (AVF) is present distal to such an obstruction, massive venous hypertension may occur producing arm edema, ulceration, and tissue loss. Management of the complications of hemodialysis access is now an integral part of vascular practice, and significant efforts are made to maintain patency of existing grafts. Surgical treatment is often difficult and may be sometimes hazardous and not always be successful. However, an endovascular therapy which is a less invasive

approach requires a dedicated and experienced interventional team approach to achieve a satisfying result.¹

Thus, the optimal management strategy is unknown. We retrospectively examined the outcomes of PTA with or without stenting of central venous stenosis in patients with compromised upper extremity hemodialysis access at our institution. The current study was undertaken to assess the feasibility and clinical success of endovascular approach for the treatment of symptomatic central venous stenosis associated with significant ipsilateral limb edema. In this article, we discuss the relative efficacy of the different endovascular and surgical treatment options, with particular interest in their short-term, intermediate/long-term results.

2. Materials and methods

2.1. Study design

This was a retrospective study approved by the departmental ethical committee. Informed written consent was obtained from

* Corresponding author.

E-mail addresses: dr.ashwal@gmail.com (A. AJ), razakkaup@gmail.com (A. Razak UK), padmakumar69@yahoo.co.in (P. R.), paiumeshm@gmail.com (U. Pai), msudhakar88@gmail.com (S. M).

all the patients. A total of 10 patients with central venous stenosis who underwent percutaneous endovascular treatment in the department of Cardiology were included. All the patients were on hemodialysis with chronic renal failure under the Nephrology department of our institute. Mean duration of dialysis before the intervention was 56.8 months (range: 8 months–12 years). All cases had autogenous AVF on the same side of central vein stenosis for dialysis access.

Indications for treatment were excessive swelling in the arm (eg: extent of the upper limb edema whether till wrist/elbow/shoulder/entire arm with chest and face), decreasing flow during dialysis, increasing venous pressures and change in the bruit/pulse. Pre-procedure contrast-enhanced CT (CECT) was done in all patients for objective documentation and extent of the lesion. Pre-procedure CECT helped in planning the intervention like the possible size of the stents and any additional lesions in the inflow or outflow of the fistula. Patients chart and database was prepared which included the duration of dialysis, duration of symptoms, type of the fistula type and date and type of endovascular treatment (Table 1). Demographic details like age, sex, history of smoking, diabetes, hypertension and risk factors like central vein catheter placement were recorded.

2.2. Technique

All patients received 5000 units of heparin intravenously. A combined approach using both radial artery and common femoral veins was used in all the patients except one. After obtaining the access, the access site was secured using short 7F–10F sheaths (compatible with balloon and stent placement) in the femoral vein and 6F sheath in the radial artery. In one case direct access through the left AV fistula with a 6F sheath was used due to the feeble ipsilateral radial artery. A long sheath like Mullins (Cook Inc., Bloomington, IN, USA) was used in femoral approach in 4 cases to help better support in the tracking of the stents and balloons. Angiography was done by both the accesses to determine the extent and length of the lesion.

The stenotic site was traversed using a 0.035 in. hydrophilic guidewire (Terumo, NJ, USA). Lesions were crossed antegrade in 5 cases and retrograde in 5 cases. The stiff end of the guidewire was also used to cross the lesion in one case. In one case coronary wires with higher tip strengths like Gaia 3 (Asahi Intecc Co., LTD, Thailand) was used to cross the lesion. Over these wires, coronary guide catheters like 6F Judkins right catheter was used to cross the lesions in 7 cases and a stiff wire (Amplatz; Boston Scientific, Marlborough, USA) was exchanged. Slip cath (Cook Inc., Bloomington, IN, USA) was used in one case where the coronary wire was used for crossing the lesion. Quick-cross (Spectranetics Corp., Colorado Springs, USA) and CXI (Cook Inc., Bloomington, IN, USA) catheters were used in one case each to exchange with the stiff wire. PTA was performed subsequently. PTA balloon diameter ranged from 1.5 to 10 mm with burst pressures between 16 and 20 atmospheres. Length of the balloons ranged from 8 to 60 mm. The various balloons used were: Admiral balloon (Invatec, Roncadelle BS, Italy), Opto pro balloon (Cordis Corporation, USA), Advance (Cook Inc., Bloomington, USA), coronary balloons like Tazuna (Terumo Corporation, Japan), Minitrek (Abbot Vascular, Santa Clara, USA), Artemis (BrosMed Medical Co., LTD). A balloon having a diameter of 1–2 mm smaller than the adjacent normal vein was selected and angioplasty was done by inflating the balloon for 30 s. Stenting was performed in the patients when residual stenosis after PTA was more than 50%. The diameter of the stent was the same as the adjacent normal vein. In all cases, bare metallic stents were used: Cook Silver 635 SE (Cook Inc., Bloomington, IN, USA), Complete SE (Medtronic, Inc., USA), Scuba (Invatec, Roncadelle BS, Italy), Protégé (eV3 endovascular Inc., USA) Visipro EV3

(eV3 endovascular Inc., USA). Stent diameters ranged from 9 to 14 mm, with length ranging from 30 to 80 mm. Post-dilatation was done using Conquest (Bard Inc.), Admiral balloon (Invatec, Roncadelle BS, Italy) and, Scuba (Invatec, Roncadelle BS, Italy) balloons at 10–20 ATM. Self-expanding nitinol stents were used in four patients. In the remaining four patients balloon expanding bare metal stents were used. In one patient, nitinol stent was used overlapping with the balloon expanding stent as the latter slipped during inflation and another stent had to be used to cover the lesion.

Radial access was taken in all but one patient. Fistulogram was done and entire fistula course was assessed for any lesions before central vein stenting. If the fistula is patent, even the direct access through the fistula outflow is also a good option, although it carries a small risk of undertreating lesions in the inflow. We used femoral access in all the patients as we thought it may be easy to use Mullins sheath and deliver the stents as big as 10–14 mm in diameter which could have been difficult through the radial or the direct fistula access.

2.3. Data analysis

Central veins were divided into five segments which included bilateral brachiocephalic (innominate) veins, bilateral subclavian veins, and superior vena cava. All the angiographic data were analyzed by two independent cardiologists with regards to site and degree of occlusion, a number of segments occluded and the procedure performed. Data were collected as the success rate, 6 months and 12 months patency rates, complication during and after the procedure, possible causes for the restenosis.

Technical success was defined as a procedure without significant residual stenosis with more than 50% gain in the luminal diameter and no complications. Technical failure was defined as the inability to cross/dilate the lesion. A complication was defined as any event not routinely observed after the procedure which required treatment with endovascular or surgical intervention within 30 days of the procedure. Primary patency is defined as a central vein which is patent without recurrence of stenosis or requirement of repeat intervention. Secondary patency/assisted primary patency is defined as a central vein that underwent a repeat intervention after the primary procedure. Residual stenosis was defined as more than or equal to 30% stenosis compared to the adjacent normal vein. Stenting was considered in all patients with residual lesion of more than 50%.

3. Results

A total of 10 patients underwent 13 interventions for the endovascular treatment of CVD. The study comprised 6 men and 4 women with a mean age of 45.2 years (range, 26–66 years). All the patients had hypertension. Six patients had diabetes. Three patients were smokers. All the patients had a history of internal jugular vein cannulation for hemodialysis. Eight cases had left innominate vein stenosis and 2 cases had right innominate vein – superior vena cava stenosis (total 12 segments). Average lesion length was 35.34 mm and the lesions ranged from 21.1 mm to 57 mm.

The length of the stenotic segment was 2–3 cm in five patients and 3–5 cm in 2 patients. Three patients had long segment involvement of >5 cm. One patient underwent primary PTA [Fig. 1A–D]. Seven patients underwent primary PTA and stenting. Three patients underwent secondary PTA. One among these patients underwent secondary PTA twice along with fistuloplasty [Fig. 2A–J]. One patient underwent secondary PTA with stenting [Fig. 3A–D].

Symptomatic improvement in the form of a reduction in the arm edema, improvement in the dialysis pressures and flow was

Table 1
Demographic data and procedural details of the patients.

	Age	Sex	Duration of HD	Duration of Central Venous Stenosis	Site of Stenosis	Crossing of the lesion	Length of the Lesion	Guide Catheter	Guide wires Diameter in mm	Balloons Used	Stents Used	Post Dilation	Primary Patency (month)	Secondary Patency (month)	Repeat procedure
1	52	M	8 years	2 weeks	(R) innominate vein + superior venacava 100%	Anterograde Crossing Access: Radial artery	52 mm	6FJR 3.5 Slip Cath	0.035 Terumo Snare Kit Amplantz	4*20 Admiral at 4–6 ATM 8*60 Optopro at 4–6 ATM	14*60 Cook Zilver 635 SE Bard at 16 ATM	24			No Recurrence
2	31	F	1 year	1 week	(L) Innominate 100%	Retrograde Crossing Access: Femoral vein	21.1 mm	6FJR 3.5 7F Mullins	0.035 Terumo Snare Kit Amplantz	8*40 Admiral at 10 ATM	10*40 Complete SE 10*37 Scuba @ 16ATM		16		No Recurrence
3	50	M	12 years	1 month	(L) Innominate 100%	Anterograd Crossing Access: Radial artery	25.5 mm	6FMPA 6FJR 3.5	0.035 Terumo Amplantz	6*40 Admiral at 8 ATM 10*40 Admiral Xtreme at 10 ATM			33		No Recurrence
4	60	M	nil	3 days	(L) Innominate 100%	Antero grade crossing Access: Left AV Fistula	26.6 mm	6FJR 3.5 7F Mullins	0.035 Terumo Quick cross Amplantz	7*40 Admiral at 8 ATM	9*37 Scuba at 14 ATM		8	6	Underwent repeat PTA due to complete stent re-occlusion with good results
5	27	F	3 years	2 weeks	(L) Innominate 70% P Gr 20 mmHg	Retrograde Crossing Access: Femoral vein	24 mm	6FJR 3.5 7F Mullins	0.035 Terumo Amplantz	Direct stenting	10*30 Scuba at 12 ATM		10	Deferred Second procedure	Follow Up CT angio after 12 months Stent Deformed with significant restenosis No Recurrence
6	32	F	3 years	6 months	(L) Innominate 100% S/p PTA 10*40 complete SE iliac stent	Retrograde Crossing Access: Femoral vein	57 mm	6FJR 3.5 7F Mullins	Gaia 2 sliipcath 0.035 Terumo Amplantz	1.5 *10 Tazuna @ 10 ATM 2*8 Minitrek @ 16 ATM 2.5 *15 Artemis @ 16 ATM 4*40 Cook @ 20 ATM	10*80 EV3 Protégé (SE) Admiral @16 ATM	9*20 Scuba @16 ATM	5	6	No Recurrence
7	57	M	4 years	2 months	(L) Innominate 100%	Retrograde Crossing Access: Femoral vein	36.6 mm	6FJR 3.5 7F Mullins	0.035 Terumo CXI Micro Catheter Amplantz	4*20 Cook @ 10 ATM 6*20 Cook @10 ATM	10*57 Visipro EV3 @12 ATM		4	3	Underwent repeat PTA twice within 3 months with good results. .
8	26	F	8 months	1 week	(L) Innominate 100%	Retrograde Crossing Access: Femoral vein	30.3 mm	6FJR 3.5 7F Mullins	0.035 Terumo Amplantz	5*20 Admiral @ 8 ATM	9*55 Scuba @10 ATM		10	Deferred Second procedure	Follow up CT angio after 10 months Stnet # with migration to IVC
9	51	M	5 years	9 months	(L) Innominate 100%	Anterograde crossing Access: Radial artery	28.3 mm	6FJR 3.5 7F Mullins	0.035 Terumo Amplantz	5*20 Admiral @ 10 ATM 8*30 Scuba @12 ATM	10*60 complete SE Scuba @ 16 ATM		8		No Recurrence
10	66	M	4 years	2 month	((R) innominate vein + superior venacava 100% s/p PTA 10*40 complete SE iliac stent	Anterograde crossing Access: Radial artery	52 mm	6FJR 3.5 7F Mullins	0.035 Terumo Amplantz	9*30 Opto Pro @ 8–12 ATM			3	1	Patient died due to natural cause After 1 month

Balloons and stents are expressed as diameter * length in mm; Catheters are 6 French (F) Judkins Right (JR) with curve 3.5; ATM = atmosphere pressure; @ = at.

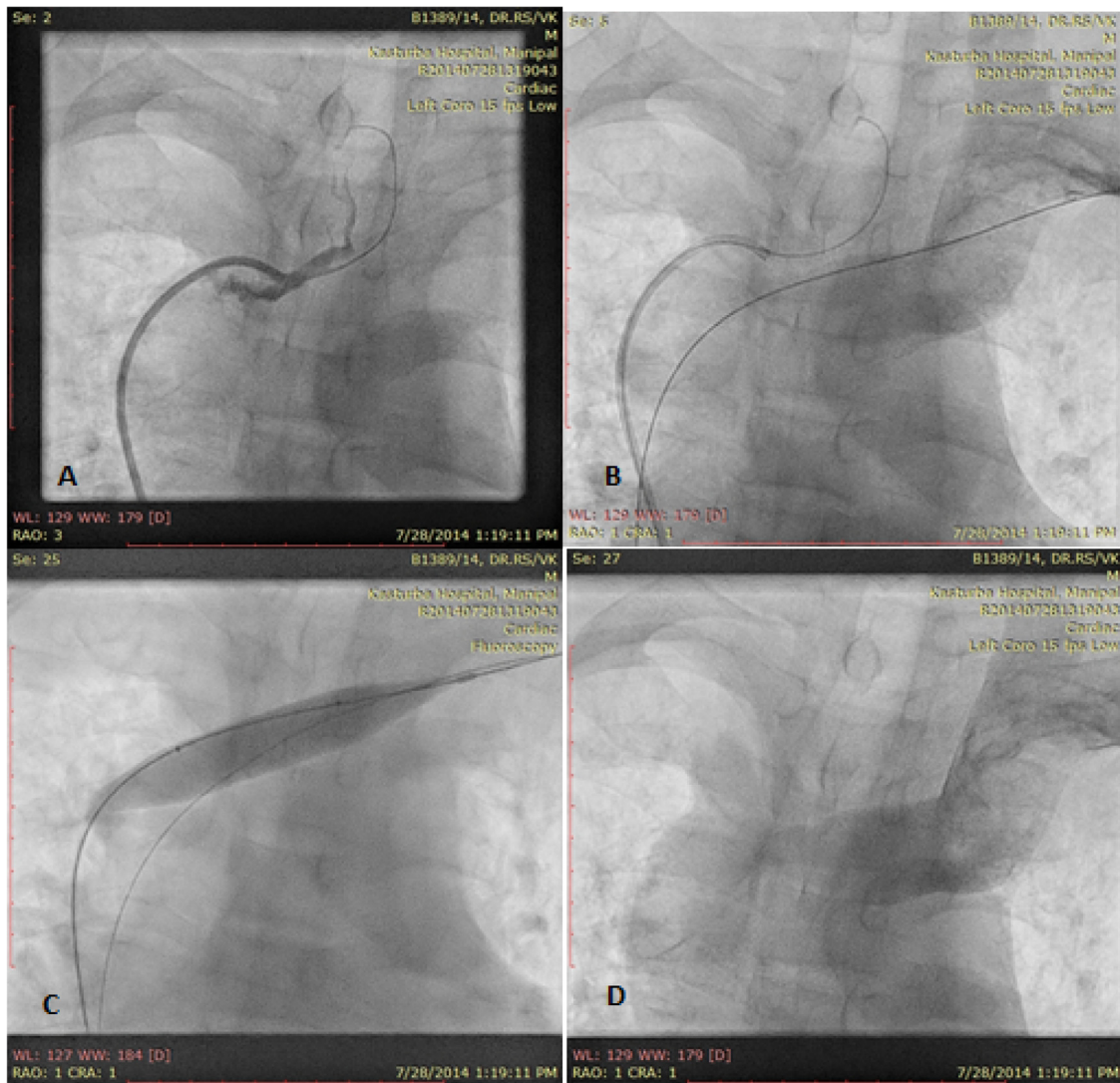


Fig. 1. (A–D) A 50-year-old male with AVF in the left arm presented with swelling of left arm and face. (A) Initial diagnostic venogram showed complete occlusion of left brachiocephalic vein (B) Lesion was crossed using 0.035 Terumo anterogradely. (C) PTA was performed using 6 × 40 Admiral at 8 ATM, 10 × 10 Admiral Xtreme balloon at 10 ATM (D) Post PTA venogram showed normal filling of left brachiocephalic vein. Patient on follow up for 33 months with no recurrence of symptoms.

reported in all the patients with no major peri-procedural morbidity or mortality.

Total six patients had a recurrence of symptoms. Among them, two had undergone central vein stenting previously at other centers. They had a recurrence of symptoms at 5 and 3 months (mean 4 months) after the primary procedure respectively. One patient underwent only PTA and other patient underwent PTA with stenting. One of these patients died during follow-up at 4 months after the primary intervention due to non-intervention related causes. He had associated co-morbidities like diabetes, hypertension and ischemic heart disease (IHD). In other four patients who had a recurrence of symptoms, mean intervention-free period was 8 months. They underwent CT angiography which revealed stent fracture and migration of the distal fragment of the stent into the inferior vena-cava in one of the patients. One patient had stent compression and restenosis. Two patients had complete occlusion of the stented segments. Among these four patients, two underwent re-intervention in the form of PTA with good result. One of this patient presented again with complete occlusion of the fistula as well as the stented segment after 3 months of secondary PTA and underwent repeat PTA with good result. In

other two patients, re-intervention was deferred in view of stent fracture and migration/distortion.

Immediate complication encountered was localized extravasation during difficult manipulation of the guidewire (n = 3). Delayed complications were stent fracture/migration with restenosis (n = 1) [Fig. 4A and B] and restenosis (n = 6) and stent compression with restenosis (n = 1) [Fig. 5A and B].

All patients were followed up for the recurrence of symptoms like swelling of the limb, efficiency of the flow during dialysis and those with symptoms were called and evaluated by CT angiography (n = 4) and peripheral angiography (n = 2). Follow-up was either personal visits of the patients or the telephonic conversation with the patients. The reappearance of the swelling of the limb was assessed by the patient as to the extent of involvement like the only wrist, till the elbow or the whole limb with or without face. Patients were also told to report decreasing flow during dialysis, increasing venous pressures and change in the bruit/pulse and such patients were called to the hospital and assessed by either Doppler or CT angio for the patency of the fistula as well as the stented central vein.

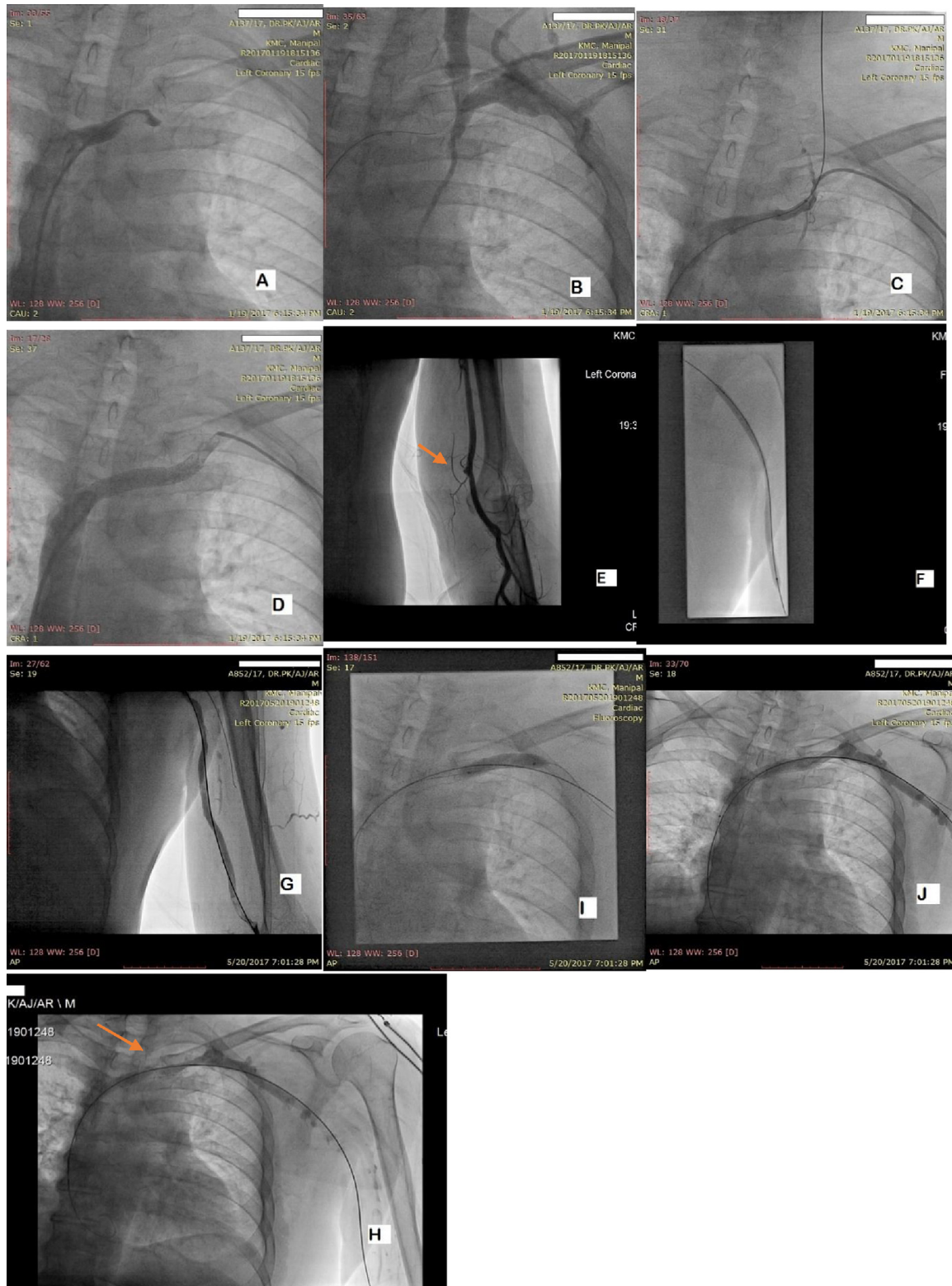


Fig. 2. (A–J) A 57-year-old male patient with AVF in the left arm presented with left arm swelling. (A) Initial venogram showed complete occlusion of left brachiocephalic vein Lesion (B) It was crossed using 0.035 Terumo retrogradely (C) PTA was done using 4×20 Cook balloon @ 10 ATM and 6×20 Cook balloon @ 10 ATM (D) Post PTA venogram showed residual stenosis more than 50% and hence stented with 10×57 Visipro EV3 stents @ 12 ATM with normal filling of the left brachiocephalic vein. (E) The patient presented with complete occlusion of the AV fistula after 4 months (arrow in E) (F) and (G) Fistuloplasty was done with good flow. (H) However, there was restenosis with in-stent and edge stenosis (arrow in H) (I) Repeat balloon venoplasty was done (J) Post venoplasty result with approximately 100% opening of brachiocephalic vein. However, he presented with one more episode of complete occlusion of the AV fistula within 3 months and repeat fistuloplasty and balloon venoplasty was done.

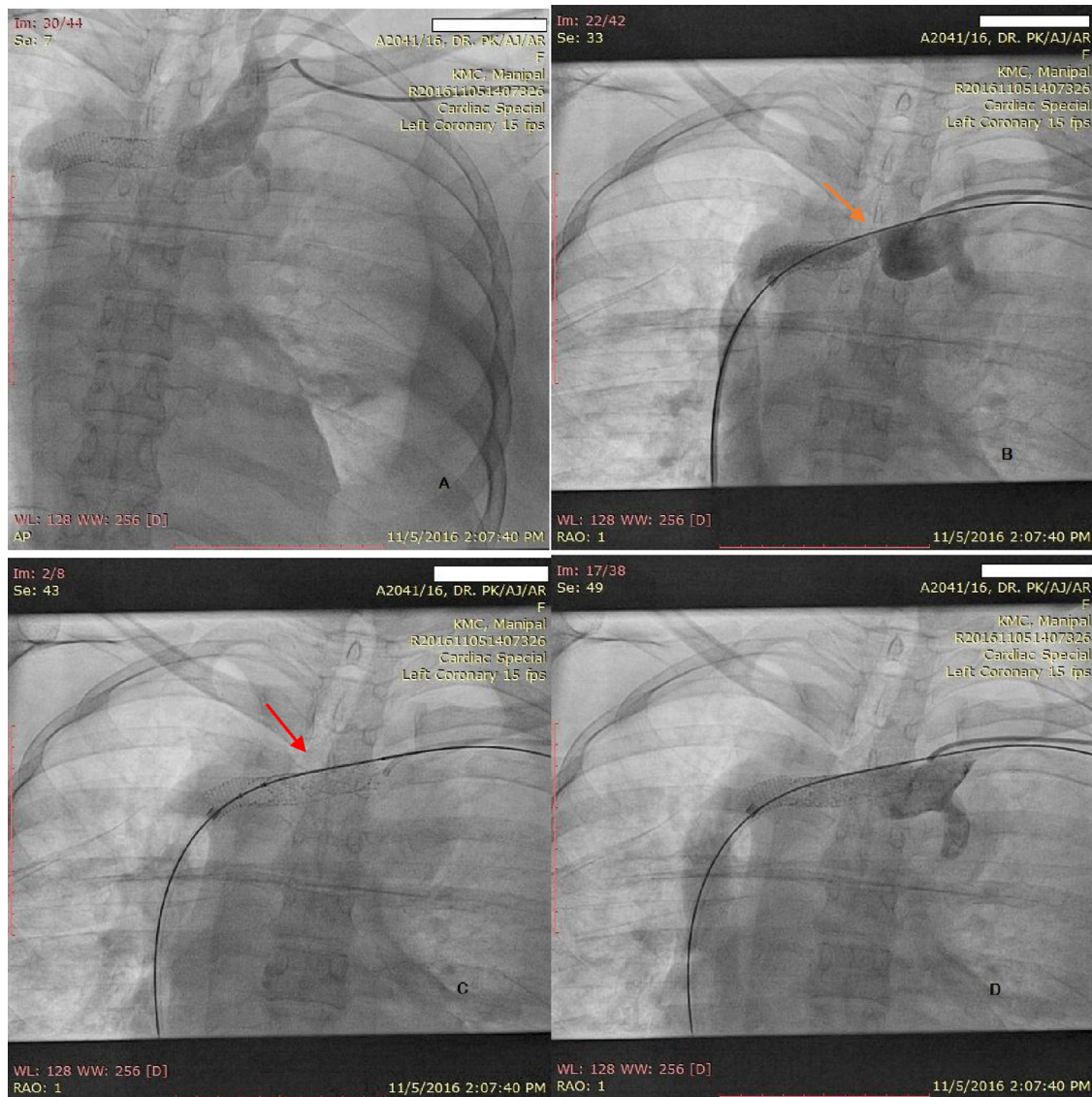


Fig. 3. (A–D) A 32-year-old female patient with AVF in the left arm presented with left arm swelling. She had undergone PTA and stenting to left brachiocephalic vein with 10×40 mm Complete SE stent 5 months back (A) Initial venogram showed complete occlusion of left brachiocephalic vein. PTA was done 1.5×10 Tazuna @ 10 ATM, 2×8 Minitrek @ 16 ATM, 2.5×15 Artemis @ 16 ATM, 4×40 Cook @ 20 ATM, 9×40 mm Cook balloon @ 16 ATM (B) Post PTA venogram showed filling of left brachiocephalic vein with residual significant lesion. (Arrow) (C) Repeat venoplasty followed by stenting with 10×80 EV3 Protégé self-expanding stent was done (Arrow). (D) Post dilatation was done with 9×20 Admiral Balloon @ 16 ATM. (F) Post stenting venogram showed normal filling of the left brachiocephalic vein.

Our study shows a primary patency rate of 67% and 33% at 6 months and 12 months for PTA with stenting. Our study also shows secondary or assisted primary patency of 75% at 6 months of follow-up.

Flowchart showing follow-up of patients with primary and secondary endovascular procedure

4. Discussion

Percutaneous angioplasty is the minimally invasive procedure and is well tolerated by patients with the end-stage renal disease. Even though balloon angioplasty is very effective in treating arterial atherosclerotic lesions, its efficacy in dilating venous lesions which develop in association with an arteriovenous fistula is questionable.

Several surgical approaches in the management of central venous occlusions have been advocated, which include jugular venous turndown, interposition grafting to the internal jugular vein, and direct patch angioplasty of axillo-subclavian stenosis The

results of surgical reconstruction of mediastinal veins in hemodialysis patients are better than those of interventional radiology with primary patency rates of 80% to 90% at one year.¹ However, these procedures are difficult to perform due to the magnitude of the intervention required in a patient who frequently has numerous comorbidities.¹ These procedures are always major surgeries. Patch angioplasty of an innominate vein/subclavian or the orthotopic bypass surgeries, many times require clavicular division or sternotomy along with general anesthesia. They are associated with high rates of postoperative morbidity and mortality. Extra-anatomical bypass like axillary-to-internal jugular vein is less distressing to the patient but this again results in the loss of another central vein for further access.^{1,2}

In the dialysis patients, the factors responsible for central venous stenosis are mainly (1) temporary central venous catheterization, like subclavian vein access^{3–6} and (2) the high-flow state with the creation of an arteriovenous shunt which has increased turbulence.^{7,8}

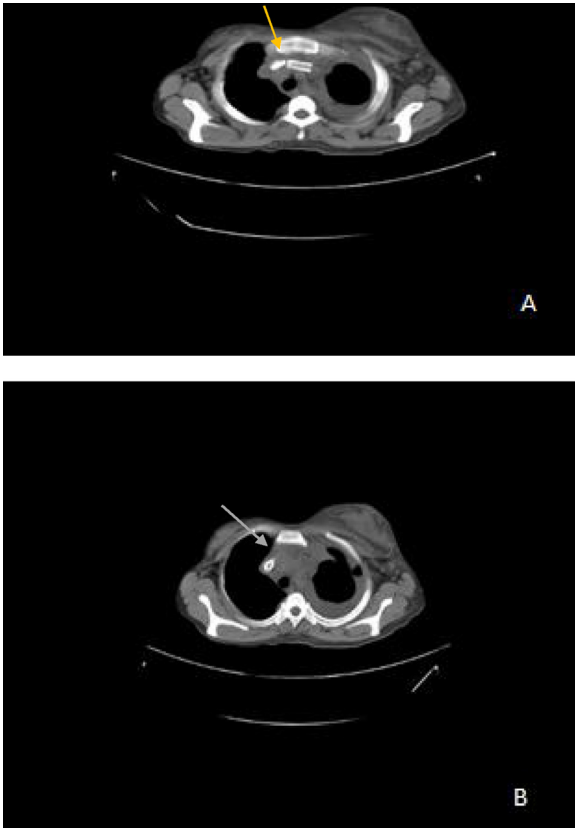


Fig. 4. (A) CT angio of the left brachiocephalic vein in transverse section showing stent fracture with complete occlusion of the flow in one of the patients. (B) CT Angio of the lower thorax region in transverse section showing the fragment of the stent in the proximal IVC.

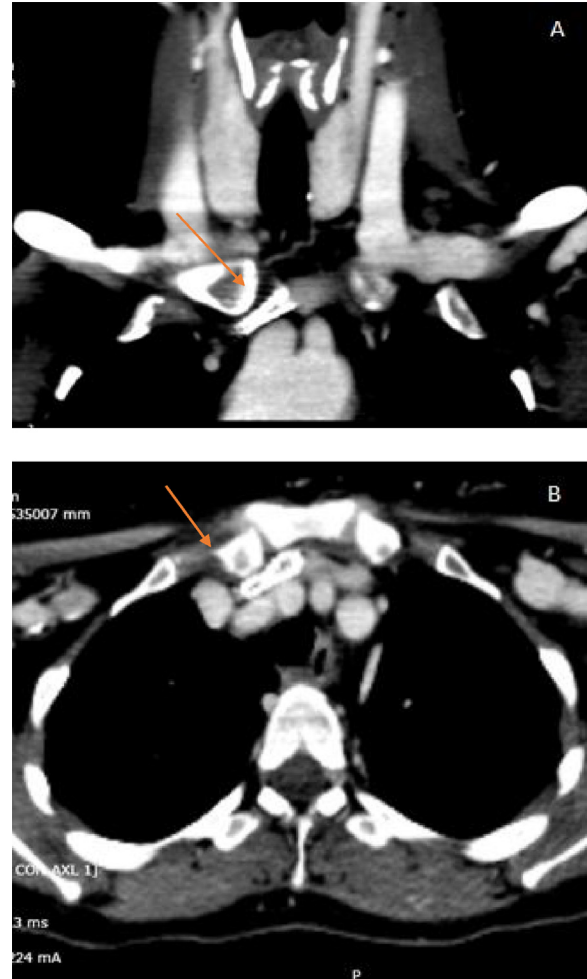


Fig. 5. (A) CT Angio of the left brachiocephalic vein in coronal section showing stent compression in the proximal part of the brachiocephalic vein. (B) CT Angio of the left brachiocephalic vein in transverse section showing stent compression in the proximal part of the brachiocephalic vein.

The initial technical success rate in our case series was 100%. For PTA, technical success rates from 70 to 90% have been reported.^{9–15} Very high technical success rates have been reported for bare metallic stenting in the literature, ranging from 90 to 100%.^{16–21} A recent study by Yadav et al²² has reported a technical success rate of 81.8%.

In previous studies, primary patency rates for PTA ranged from 23 to 55% at 6 months and from 12 to 50% at 12 months.^{9–15,17} With bare metallic stenting, primary patency rates of 63–100% at 3 months, 42–89% at 6 months, and 14–73% at 12 months have been reported.^{11,16–21,23}

Our study shows a primary patency rate of 67% and 33% at 6 months and 12 months for PTA with stenting. Our study also shows secondary or assisted primary patency of 75% at 6 months of follow up. Among ten of our patients nine underwent PTA and stenting cumulatively and one only PTA. Among these nine patients who underwent PTA with stenting, six patients had a recurrence of symptoms and had stent restenosis with or without stent distortion. This correlates well with Nael K et al²⁴ who reported a primary patency rates at 1, 6, and 12 months were 81%, 46%, and 22%, respectively ($P = 0.001$) and assisted patency rates of 91%, 77%, and 63% at 1, 6, and 12 months, respectively. Similar observations are made by Massara et al²⁵ where they recorded a primary patency rate of 95%, 80%, and 70% respectively at 6, 12 and 18 months; secondary patency rate of 100%, 95% and 90% at 6, 12 and 18 months.

It is a dilemma during the intervention whether to use stents or not. Many of the previous studies fail to demonstrate whether

stenting provides additional benefit. Quinn et al¹² compared PTA versus stenting in peripheral and central lesions and reported the patency rates in central lesions were equal at 1 year. However, Oderich et al²⁶ suggest that stenting improves the long-term results for central venous lesions. In a study by Bakken et al¹¹ primary patency was equal between PTA and PTA + stenting groups with 30 day rates of 76% for both groups and 12-month rates of 29% for PTA and 21% for PTA + stenting ($P = 0.48$). Assisted primary patency/secondary patency was also equal ($P = 0.008$), with a 30 day patency rate of 81% and 12-month rate of 73% for the PTA group, vs PTA + stenting patency rates of 84% at 30 days, and 46% at 12 months. This was the reason we opted to stent only if the residual lesion was more than 50% which was considered as a technical failure if unable to achieve.

Elastic recoil is thought to be the primary cause for early restenosis in patients who underwent only PTA.²⁷ Hemodynamic stress and turbulence due to high blood flow in arteriovenous fistula have been implicated in causing intimal hyperplasia, thereby leading to stent restenosis.²⁸

Nitinol stents are known to provide greater flexibility and resistance against kinking. However, in two previous studies, no significant difference was found between the patencies of wall stents and nitinol-based stents.^{29,30} But in some studies, nitinol stents provided better patency rates than wall stent.³¹ There is a

controversy regarding the use of covered stents. Some studies have reported the use of covered stents or brachytherapy does not enhance the patency,^{16,32} but a study by Kundu et al³³ reports a primary patency of 100% at 3, 6 and 9 months. Likewise one of the studies involving 30 patients has reported primary patency rates of 97%, 81%, 67%, and 45% at 3, 6, 12, and 24 months respectively and primary assisted patency rates of 100%, 100%, 80%, and 75% at 3, 6, 12, and 24 months, respectively and is very promising.³⁴ However, few others have also shown the primary treatment area patency rates at 30 days and 180 days as low as 75% and 31% respectively and secondary patency rates at the same time points to be 88% and 68% respectively.³⁵ In this study mean primary treatment area patency was 93 days. A study by Anthony G et al has also shown lesion patency rates at 6, 12, 24, and 36 months to be 60%, 40%, 28%, and 28%.³⁶ But all these studies involve less than 100 patients and have a short-term follow up. Thus we suggest that controlled, randomized clinical trials with a large number of patients are required in this regard before making a final conclusion.

In our study, two patients had late complications like stent fracture and migration of the distal stent fragment to inferior vena cava in one patient and stent compression and distortion in another patient. Both patients had balloon expandable stents. Most probably the cause of this complication may be the compression between the clavicle and the great vessels. It is a well-known fact that self-expanding nitinol stents have higher radial strength when compared to balloon expandable stents. However, as the venous lesions are more fibrotic and rigid than the arterial lesions in general, operators had preferred balloon expandable stents in these patients. But with our experience, we suggest self-expanding nitinol stents might be a better option due to higher radial strengths.

We have reported only our initial experience and further studies for longer time duration and a larger sample size will be needed to assess long-term outcomes in the Indian population. We have taken radial access in the patients as the operators were very well versed with the access approach. Arterial access can sometimes lead to local site complications. It is possible that the lesions can also be approached from the femoral vein as well as directly through the fistula. If any inflow lesions are suspected, they can be dealt retrogradely from the fistula. The choice of the stents was left to the discretion of the operator and availability of the type of the stent with correct sizes. There is also no definite guideline/policy regarding the use of the balloons or the stents in these procedures as the experience is quite rare.

5. Conclusion

Even though the number of patients in our study is small, we propose stenting preferably with self-expanding nitinol stents, improves short-term and intermediate-term results and may not prevent the long-term complication like restenosis as stenting carries the risk of fracture and distortion as well the hemodynamic stress of high flow due to fistula remain untreated. All though with the advances in the interventional approach, the review of the literature shows similar patency rates during the past 10 years. With growing population of patients with hemodialysis, this demonstrates the complexity of this entity and need to improve the diagnostic and therapeutic approach.

Conflicts of interest

None.

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None.

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