# Treatment of hemodialysis related-central venous stenosis: 1-year results of venoplasty and follow-up in 50 patients

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**Purpose**
To analyze and evaluate the patency of the endovascular intervention for venous hypertension in upper-extremity hemodialysis access.
**Patients and methods**
A prospective cohort study of consecutive patients with chronic renal failure having symptomatic central venous stenotic lesions with hemodialysis access referred for endovascular treatment was conducted from May 2015 to May 2016. Procedure consisted of percutaneous angioplasty with or without stenting.
**Results**
A total of 50 patients (30 females and 20 males, with mean age of 47.7 years and range of 22–72 years) were included, and all had successful arteriovenous fistula (AVF) creation (native in 76% of patients and synthetic in 24% of patients). Overall, 64% of the patients had left-sided AVF, and the remaining 36% had right-sided AVF. Patency rates of 34 patients collectively were 100, 97, and 70% at 3, 6, and 12 months, respectively. One-year patency rate of cases with single-lesion group was 91.6%, and those with multiple lesions was 8.3%, with statistically significant difference between the two groups. However, the term patency rate for patients with short lesions (<3 cm) was 66.6% and for those with lesions more than 3 cm was 33.3%. This was statistically insignificant, with *P* value equal to 0.1.
**Conclusion**
Percutaneous central venous angioplasty could provide satisfactory symptomatic relief in patients who presented with central venous stenosis together with upper-extremity edema. Endovascular procedure offers a minimally invasive, first option of management for a difficult problem in a patient population with significant comorbidities and infrequent complications. However, the durability of percutaneous transluminal angioplasty is limited, and in most patients, adjunctive interventions were required to extend the symptom-free period.

**Keywords:**
central venous stenosis and occlusions, hemodialysis, percutaneous transluminal angioplasty

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## Introduction

Presence of central veins stenosis or occlusion in dialysis patients is considered a serious condition with greater effect on patency of hemodialysis access, which is a lifeline in patients with end-stage renal disease (ESRD), when compared with stenosis of a peripheral vein. This is because the central veins represent the final common pathway for blood flow from the periphery to the heart. If central stenosis is allowed to progress, the arteriovenous hemodialysis access may eventually be lost [1].

Dialysis vascular access planning according to National Kidney Foundation guidance, creation, and management is crucial in expecting the longevity potential of patients with ESRD. This process is best carried out using a multidisciplinary team approach, which involves the patient and his/her family, the nephrologist, the dialysis facility personnel, the surgeon, and the interventionalist [2].

When an ipsilateral arteriovenous access is placed, venous hypertension may develop and become manifested by arm swelling and pain. The optimal treatment of symptomatic venous obstruction is still controversial. Although ligation of the arteriovenous fistula (AVF) with the creation of a new access site will usually provide dramatic symptomatic improvement, this will lead to loss of dialysis access especially when other access options were exhausted. However, as the life expectancy of patients with ESRD increases, additional access sites may no longer be available. For this reason, the general recommendation has been to preserve each shunt for use as long as possible [3].



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Endovascular treatment with venoplasty with or without stenting for central venous stenosis is safe, with higher rate of technical success and shorter hospital stay. In central venous angioplasty, the complications are uncommon, and the patients' discomfort at the site of balloon insufflation may be reduced with sedatives. Occasionally, local complications caused by the wide introducers may occur, like access site bleeding, and this could be lowered with transfemoral venous access. Vessel rupture occurs only very rarely. Stent migration, pseudoaneurysm at the site of the stent, or a significant stent shortening immediately after insertion or several weeks or even months later has not been manifested in some patients [4].

## Patients and methods

This study was performed prospectively in Vascular and Endovascular Surgery Department, Assiut University Hospital, Assiut, Egypt, between May 2015 and May 2016. The study was approved by the ethics committee of Assiut University Hospital. Patients or relatives of patients with chronic renal failure provided written consent for study participation. We included all upper limb fistulae either native or synthetic complicated by venous hypertension and presented by edema of the arm, face, and breast of the affected side, in addition, the study included patients presented with painful hand ulceration, aneurysmal dilation and tortuosity of AVF, prolonged bleeding from access needle sites, and finally, presence of symptoms up to 3-month duration. We excluded young age (<18 years old), duration of symptoms longer than 3 months, lower limbs AVFs, presence of peripheral vein stenosis, congenital central veins anomalies, and existence of mediastinal syndrome.

Data collected from the studied patients included full demographic data, detailed clinical presentation with type hemodialysis access, and presence or absence of complications, together with complete laboratory studies.

Imaging studies include routine duplex scan of the central venous system to show the site and nature of lesion, an absence of normal respiratory variation in the diameter of central veins, and polyphasic atrial waves. It is difficult to visualize the central veins with duplex ultrasound in patients with an elevated BMI, or significant chest musculature. Moreover, multislice computed tomographic venography is performed as it is a more accurate method to assess patency of superficial and deep systems, including the central veins.

All data during treatment procedure such as technical success, stenting or not, type of stent used, residual stenosis, and intraoperative complication were collected.

### Follow-up of the patients

Regular follow-up of the patients after the dilatation either clinically and radiologically was advised for better correlation of the study for early detection of recurrence of the problem and determination of exact time of primary patency along every 3, 6, and 12 months.

All patients who fulfilled the study criteria gave an informed consent to confirm their participation.

### Statistical analysis

Statistical analysis was performed using SPSS, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Categorical variables were reported as numbers with percentages. Continuous variables were reported as means with SD. $\chi^2$ test was used to compare qualitative data between different groups. All $P$ values less than 0.05 were considered significant.

## Results

The study included 20 (40%) males and 30 (60%) females, with a mean age of 47.77±10.49 years (range, 22–72 years). Hypertension was a risk factor in 54% of patients (Table 1).

The AVFs were native in 38 (76%) patients, whereas synthetic AVFs were reported in 12 (24%) cases. Overall, 64% of the patients had left-sided AVFs, and the remaining 36% had right-sided AVFs. Brachiocephalic AVFs were recorded in 44% of cases, 24% of patients with upper limb basilic vein

**Table 1 Demographics and comorbidities of the studied group**

| | *n* (%) (*N*=50) |
|---|---|
| Age (years) | |
| <50 | 36 (72) |
| ≥50 | 14 (28) |
| Mean±SD (range) | 47.77±10.49 (22.0–72.0) |
| Sex | |
| Male | 20 (40) |
| Female | 30 (60) |
| Comorbidities | |
| HTN | 27 (54) |
| DM | 12 (24) |
| RHD | 1 (2) |
| None | 12 (24) |

DM, diabetes mellitus; HTN, hypertension.

transposition, and 8% with upper limb radiocephalic AVFs, as in Table 2.

The lesions were most commonly located in the innominate vein. It was involved in 32 (64%) of patients, followed by the subclavian vein in 10 (20%) of patients, the axillary vein in 11 (22%), and superior vena cava in four patients. Regarding the nature of the lesions of central veins, stenosis was recorded in 80% of the patients, and the remaining 20% were occlusive in origin (Table 3).

**Table 2 Characteristics of the arteriovenous fistula**

| | *n* (%) (*N*=50) |
|---|---|
| Type of AVF | |
| Native | 38 (76) |
| Synthetic | 12 (24) |
| Side | |
| Right | 18 (36) |
| Left | 32 (64) |
| Site of AVF | |
| UL brachiocephalic | 22 (44) |
| UL graft | 12 (24) |
| UL radiocephalic | 4 (8) |
| UL basilic vein transposition | 12 (24) |

AVF, arteriovenous fistula; UL, upper limb.

**Table 3 Procedural variables**

| Type of lesion | *n* (%) (*N*=57) |
|---|---|
| Stenosis | 44 (77.1) |
| Occlusion | 14 (24.5) |
| Site of lesion | |
| Axillary | 11 (22) |
| Subclavian | 10 (20) |
| Innominate vein | 32 (64) |
| SVC | 4 (8) |

**Table 4 Technical success of the procedure**

| Technical success | *N*=50 | |
|---|---|---|
| Successful cases | 34 | 68 |
| Unsuccessful cases | 16 | 32 |

The symptoms of cardiovascular disease varied from upper limb edema, dilated arm and chest veins, and vascular access thrombosis. There were 23 (46%) cases that presented with symptoms lasting for more than 2 months.

Initial percutaneous angioplasty was technically successful in 34 (68%) central vein lesions; (see Figures 1–3) however, in the remaining nine central vein lesions, there was failure of wire passage. Stenting of the central vein lesions was done in eight patients (Table 4).

Follow-up of a total of 34 successful cases after 1-year period revealed 24 cases were free of symptoms, whereas 10 cases had recurrent symptoms. One-year patency rate of cases with single lesion was 91.6% and for those with multiple lesions was 8.3%. There was a statistically significant difference between the patency rates of two groups (Table 5).

One-year patency rate for right-sided AVFs was 16.6% and for left-sided AVFs was 83.3%, with statistically insignificant *P* value. According to the type of AVFs, 1-year patency rate for native AVFs was 79.1% and for synthetic AVFs was 20.8%, which was statistically insignificant. However, there was a statistically significant difference in 1-year patency between groups of patients with stenotic lesions versus those with occlusive pathology (Table 6).

**Table 6 Patency rates according to arteriovenous fistula characteristics**

| | 1-year follow-up [*n* (%)] | | *P* value |
|---|---|---|---|
| | Patent (*N*=24) | Recurrent (*N*=10) | |
| Type of AVF | | | 0.4668 |
| Native | 19 (79.1) | 6 (60) | |
| Synthetic | 5 (20.8) | 4 (40) | |
| Side | | | 0.2352 |
| Right | 4 (16.6) | 7 (70) | |
| Left | 20 (83.3) | 3 (30) | |
| Type of lesion | | | 0.0001 |
| Stenosis | 20 (83.3) | 8 (80) | |
| Occlusion | 4 (16.6) | 2 (20) | |

AVF, arteriovenous fistula.

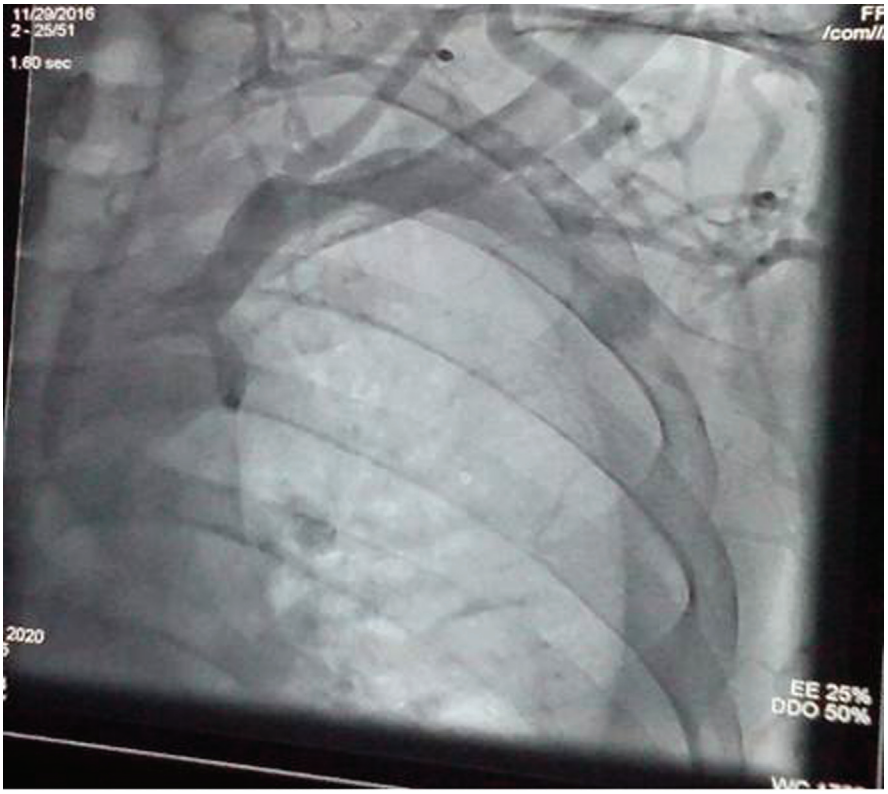
**Table 5 Patency rates according to procedural variables**

| | 1-year follow-up [*n* (%)] | | *P* value |
|---|---|---|---|
| | Patent (*N*=24) | Recurrent (*N*=10) | |
| Site of the lesions | | | 0.3 |
| Axillary vein | 5 (20.8) | 1 (10) | |
| Subclavian vein | 5 (20.8) | 1 (10) | |
| Innominate vein | 13 (54.1) | 6 (60) | |
| SVC | 1 (4.1) | 2 (20) | |
| Multiplicity of lesions | | | 0.0231 |
| Single | 22 (91.6) | 5 (50) | |
| Multiple | 2 (8.3) | 5 (50) | |

**Table 7 Patency rates of stented cases**

| | 1-year follow-up [*n* (%)] | | *P* value |
|---|---|---|---|
| | Patent (*N*=24) | Recurrent (*N*=10) | |
| Stenting | | | 0.7541 |
| Stenting group | 6 (25) | 2 (20) | |
| Nonstenting group | 18 (75) | 8 (80) | |

**Figure 1**




A case of 57-year-old man with narrowed left innominate vein presented with venous hypertension over AVF. AVF, arteriovenous fistula.

The 1-year patency rate for stented cases was 25% and was 75% for cases that had balloon venoplasty alone, which was statistically insignificant (Table 7, Figs 1–3).

## Discussion

Central venous obstruction is one of the most common reasons for dialysis access dysfunction in chronic hemodialysis patients. In most cases, this problem occurs as a chronic complication of subclavian dialysis catheters used for temporary hemodialysis access. Endovascular techniques, including percutaneous transluminal angioplasty (balloon venoplasty), have gained popularity for the initial treatment of symptomatic CVOD [5].

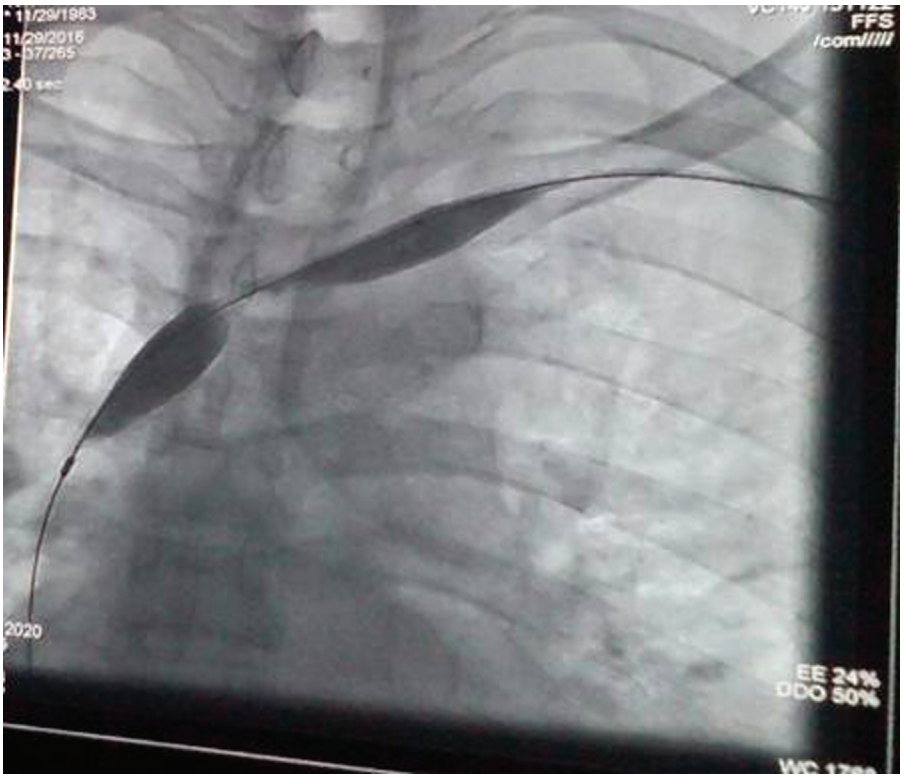
The goal of the current prospective study was to review our experience with PTA for symptomatic lesions and to determine the effectiveness of this approach for controlling symptoms and maintaining AVF patency.

We studied 50 patients with chronic renal failure, with mean age of 47.77±10.49 years, having upper limb AVF presented with venous hypertension. Overall, 60% of the patients were females and 40% were males, which is in contrast to a study done by Sprouse *et al.* [6], Shi *et al.* [7], and Oguzkurt *et al.* [8] where most of their patients were males. This was in line with Yadav *et al.* [9] and Young *et al.* [10], where most of their patients were females, representing 63.6 and 54.4%, respectively, with a mean age of 55.1 years.

We found that 54% of our patients were hypertensive. This was concomitant with Surowiec *et al.* [11] who reported that 60% of their patients were hypertensive and 48% were diabetic.

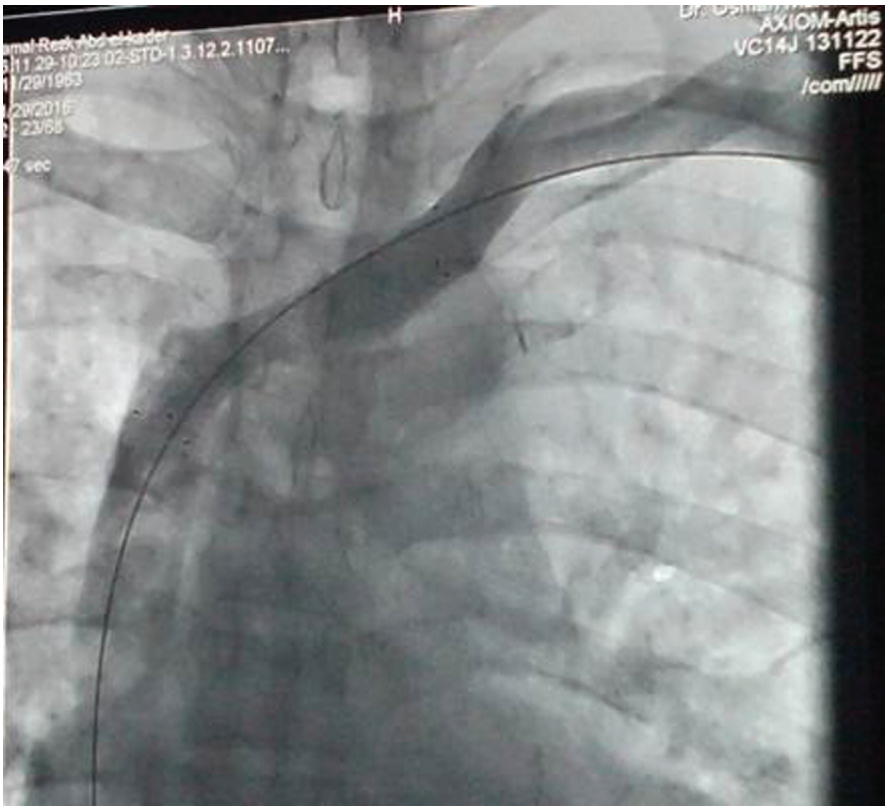
This was also in line with Nael *et al.* [12] who found that 48% of their patients were hypertensive, 45% of patients were diabetics, and 45% of patients had significant coronary artery disease.

**Figure 2**




Balloon waist during dilatation of the stenosed left innominate vein.

**Figure 3**




Completion venography demonstrating patency of the left innominate vein.

We found that 64% of lesions were left sided, whereas Yadav *et al.* [9] found that 63.6% of lesions were at the right side. This can explain the shorter period from AVF creation till the appearance of symptoms in our study, which was more than 1 year in 54% of cases, with mean±SD of 19.53±16.39 months, and longer periods in Yadav *et al.* [9], with mean±SD of 2.5 years (range, 3 months–4.5 years).

Similarly, Young *et al.* [10] found that 63.6% of the lesions were left sided; however, the mean time interval between surgical creation of the autogenous fistula and subsequent central venous intervention in this group of patients was 35±12.4 months.

We found that 76% of the AVF were native and 24% were synthetic. This is in contrast to Surowiec *et al.* [11] where 57% were synthetic. Dammers *et al.* [13], Oguzkurt *et al.* [8], Fotini *et al.* [14], and Nael *et al.* [12] found that most AVFs were native, with percentages of 54, 84, 80, and 90%, respectively.

In our study, 44% of the patients had brachiocephalic AVFs, which is in line with Nael *et al.* [12] and Oguzkurt *et al.* [8] who found that most of patients had brachiocephalic AVF, representing 69.1 and 66%, respectively. In this study, 75% of the patients had previously underwent ipsilateral central venous catheterization, mostly at jugular veins. This is in agreement with studies performed by Dammers *et al.* [13], Oguzkurt *et al.* [8], Surowiec *et al.* [11] and Kalman *et al.* [15], who observed that 86, 90, 54, and 90% of their patients, respectively, had a history of previous central vein catheters.

In our experience, the lesions were most commonly located in the innominate vein in 64% of patients followed by the axillary vein in 22% of patients, the subclavian vein in 20%, and superior vena cava in four cases. This was in agreement with Shi *et al.* [7] and Yadav *et al.* [9] who stated that most lesions were located at innominate vein, representing 91.6 and 72.7%, respectively. However, Surowiec *et al.* [11], Young *et al.* [10], and Bakken *et al.* [16] reported that most lesions were located at subclavian vein, representing 67.5, 48.6, 72.3, and 48% of their lesions, respectively.

In our study, we found that 80% of lesions were stenosis, and the remaining 20% were occlusive in nature, which is in agreement with Young *et al.* [10] and Aytekin *et al.* [17] who found that most lesions were stenosis, representing 79.2 and 78.5%, respectively. However, Dammers *et al.* [13], Shi *et al.* [7], and Yadav *et al.* [9] reported that central venous occlusion was seen in 60.7, 58.3, and 61.1%, respectively.

In this study, initial percutaneous angioplasty was technically successful in 68% of cases, keeping with Surowiec *et al.* [11], Shi *et al.* [7], and Yadav *et al.* [9], who reported that technical success rate was 89, 83.3, and 81.8%, respectively.In our study, only 16% of lesions had primary stenting, which is in agreement with Sprouse *et al.* [6], where 19% patients had stent, while study performed by Shi *et al.* [7], it reported that 55% of cases had primary stenting. In contrast, Yadav *et al.* [9] reported that PTA alone was done in two (22.22%) cases while seven (77.77%) cases had balloon angioplasty with stenting. Yadav *et al.* [9] included 11 patients, in which technical success was achieved in 81.8% cases (9/11) while the remaining two patients experienced occluded segments that could not be negotiated, giving total number of nine patients in whom the procedure was successful.

In the current study, 1-year patency rate for stented cases was 25% and 75% for cases with PTVA alone, which was statistically insignificant. This is similar to Fotini *et al.* [14] who stated that the 3-, 6-, 12-, and 24-month primary patency rates were 88.3, 65.3, 45.6, and 25.5%, respectively. This was in contrast to Shi *et al.* [7] where the primary patency rates were 48.6±18.7% in the PTA group alone, and 77.1±14.4% at 1 year after treatment in the PTA with stent group. These high rates for stent group can be explained as PTA was performed in nine cases and stent was performed in 11 cases, whereas in our study, the number of stented cases was three in 24 patients.

Moreover, the patency rates of 34 patients collectively in this study were 100, 97, and 70% at 3, 6, and 12 months, respectively. However, Shi *et al.* [7] found that the overall primary patency rates of 22 patients in whom 11 patients had stenting were 88.9±10.5, 64.8 ±10.5, and 48.6±18.7% at 3, 6 months, and 1 year postoperatively in the PTA group and 90.0±9.5 and 77.1±14.4% at 6 months and 1 year postoperatively in the stent group, respectively.

There are some limitations in this study, including the prospective and nonrandomized nature of the study. In addition, the number of patients included in this study was small, and there were mixed groups of patients, those with and those without a history of catheter indwelling. Postoperative antiplatelet medications use after the interventions were not properly

assessed, so its possible effect on patency rates could not be ensured.

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**Conflicts of interest**
There are no conflicts of interest.

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