# Role of endovascular interventions in chronic renal failure patients with central venous obstruction

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**Objective**
The purpose of this study is to evaluate the efficacy and safety of endovascular management of central venous obstruction (CVO) in chronic renal failure (CRF) patients depending on arteriovenous access.
**Patients and methods**
A prospective study was done at the Vascular Surgery Department, Zagazig University Hospitals, Egypt and Intervention Radiology Department, Alnoor Specialist Hospital, Makkah, Saudi Arabia, from July 2015 to December 2018. Twenty-five endovascular interventions were performed in 21 CRF patients with vascular accesses and symptomatic CVO. Seventeen (81%) patients reported insertion of central venous catheters. The study included 12 men and nine women. The mean age was 51±9.5 years (range: 36–65 years). The mean duration of arteriovenous access was 10±3.5 months (range: 2–17 months). The lesions were occlusion in 12 (57.1%) patients and significant stenosis in nine (42.9%) patients. The mean lesions length was 4.5±1.5 cm (range: 2–7 cm).
**Results**
Technical success occurred in 17 (81%) patients. Percutaneous transluminal angioplasty was done in 12 patients and stenting was done in five patients. We failed in four patients. Early complications occurred in three (14.3%) patients in the form of dissection in one patient, and limited contrast extravasation in two patients. Late complications occurred in five (23.8%) patients within 4–10 months in the form of restenosis in four patients and thrombosis of access in one patient. Mean intervention-free period was 5.1 months. The primary patency rates were 70.1% at 6 months and 53.5% at 12 months and secondary patency rates were 75.3 and 63.9% at 6 and 12 months, respectively
**Conclusion**
Endovascular management of CVO can be used safely in CRF patients with good results at the short run, but for long run results, regular follow-up and reinterventions are mandatory. Decreasing insertion of central venous catheters, especially in the subclavian vein, is the main prophylaxis against CVO.

**Keywords:**
central, endovascular, obstruction, venous

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## Introduction

Chronic renal failure (CRF) patients with central venous obstruction (CVO), depending on ipsilateral arteriovenous access, complain of upper limb swelling, pain and sometimes ulcers. Central venous catheter especially inserted in the subclavian vein is one of the main predisposing factors. Venous obstruction is enhanced by large volume of blood flow, and is mostly found in segments of turbulent flow [1].

Lines of management are endovascular intervention and surgery. Surgical treatment is difficult and not always successful. Endovascular procedures are balloon dilatation with or without stenting [2].

This study was done to evaluate the success and patency of endovascular procedures done for CRF patients with an arteriovenous access complaining of CVO manifestations.

## Patients and methods

We conducted our prospective study at the Vascular Surgery Department, Zagazig University Hospitals, Egypt and Intervention Radiology Department, Alnoor Specialist Hospital, Makkah, Saudi Arabia, from July 2015 to December 2018. Our patients underwent history taking, physical examination, laboratory investigations, duplex ultrasound and

some patients underwent computerized tomographic venography (CTV).

#### Inclusion criteria

CRF patients with arteriovenous access and symptomatic ipsilateral CVO in the form of Moderate or severe limb edema, impaired flow during dialysis, and prolonged bleeding after removal of lines, while the contralateral central veins are patent or there is failure of multiple arteriovenous accesses.

#### Exclusion criteria

CRF patients with bilateral CVO, with previous surgical treatment of CVO, multiple comorbid patients, and patients unfit for endovascular treatment.

#### Endovascular interventions

Insertion of 6-Fr sheath into the outflow vein or graft of the arteriovenous access and injection of contrast were done to assess the central veins. This is followed by insertion of a hydrophilic 0.035-inch guide wire (Boston Scientific, Chaska, Minnesota, USA) supported by a balloon or Bernstein catheter to cross the lesion. We inserted another 6–10 Fr sheath in the femoral vein if we could not cross the lesion and in some cases of stenting. We used balloons of diameters 10–16 mm and lengths 40 and 60 mm (Boston Scientific, Galway, Ireland). Our strategy was balloon dilatation, but stenting was reserved for elastic recoil and long-venous occlusion and complications. When stenting was decided and the outflow vein is big, stent was introduced sheath less or through a big sheath. But if the outflow vein is not big enough, the wire was guided to the femoral sheath and then the stent was introduced sheath less or through a big sheath through the femoral vein. We used wall stents (Boston Scientific) of diameters 12–18 mm and lengths 40–80 mm. Routine postdilation was done. After endovascular intervention, the patients were subjected to clinical assessment and duplex every 3 months. If symptoms recurred, they were managed by re-percutaneous transluminal angioplasty (PTA) with or without stenting.

#### Statistical analysis

Continuous (quantitative) variables were expressed as mean±SD while the categorical (qualitative) variables were expressed as a number (percentage). Duration of primary patency was defined as the duration between first endovascular intervention till restenosis following first intervention only or censored at the time of either last follow-up visit at which patient was free or dead. Duration of secondary patency was defined as duration between first endovascular intervention till restenosis following both first and second interventions or censored at time of either last follow-up visit at which patient was free or death. To estimate the patency rate at 3, 6, 9, and 12 months, we used the life table method. Time-to-event distributions were estimated using the method of Kaplan–Meier plot. All data were analyzed using statistical package for the social sciences for Windows version 18.0 (SPSS Inc., Chicago, Illinois, USA) and MedCalc Windows (MedCalc Software bvba 18, Ostend, Belgium).

## Results

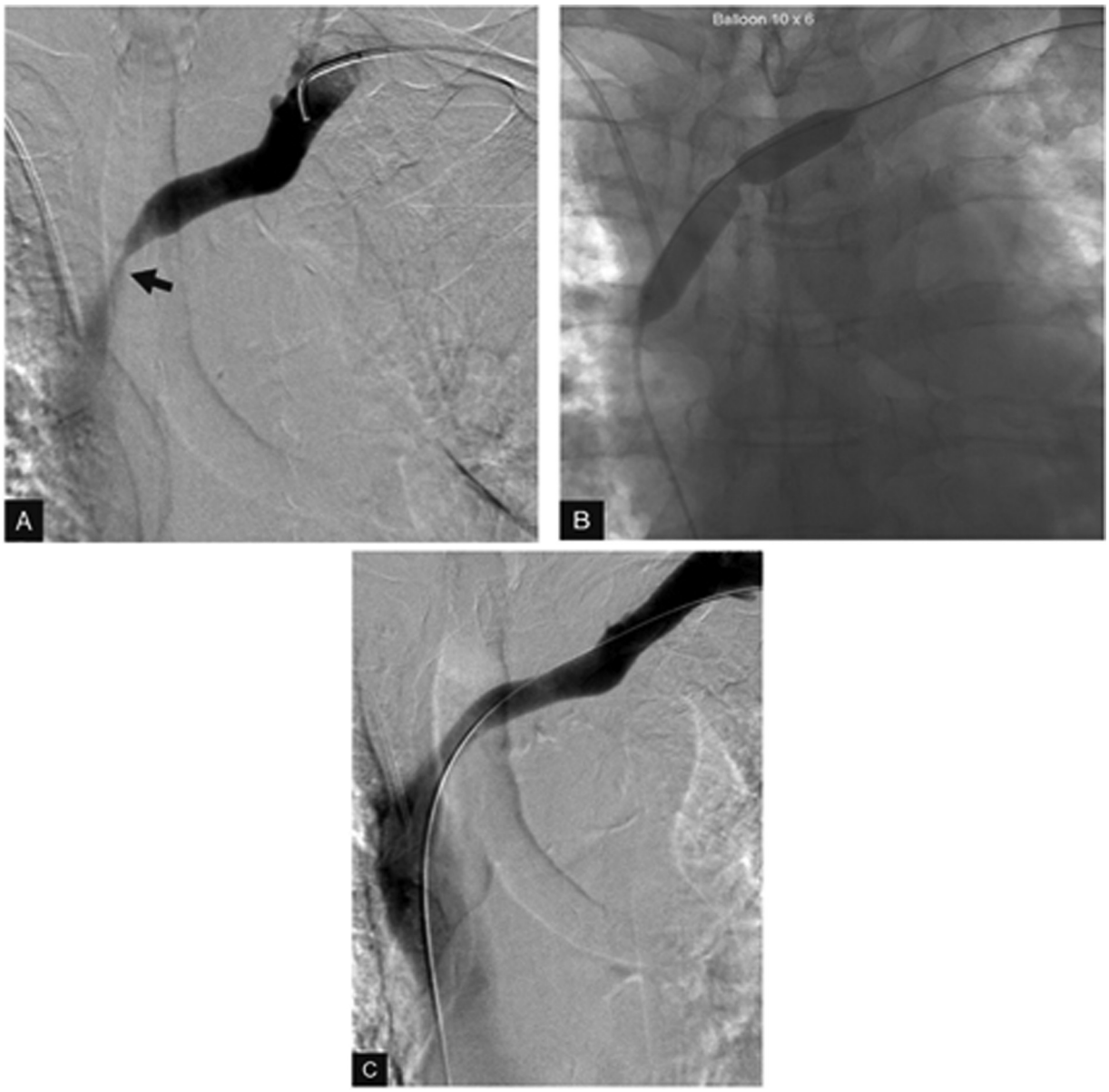
Twenty-five interventions were performed in 21 cases with vascular accesses and symptomatic CVO. Two patients had radio cephalic arteriovenous fistulas, six patients had brachiocephalic arteriovenous fistulas and eight patients had brachiobasilic arteriovenous fistulas and five patients had arteriovenous grafts (one forearm prosthetic loop and four upper arm prosthetic grafts). Seventeen (81%) patients reported insertion of central venous catheters (13 patients in the subclavian vein and four patients in the internal jugular vein). The study included 12 men and nine women. The mean age was 51±9.5 years (range: 36–65 years). Eleven patients had involvement of right-sided venous system and 10 patients had involvement of the left side. The mean duration of arteriovenous access was 10±3.5 months (range: 2–17 months). The lesions were in the Proximal cephalic vein in one (4.8%) patient (100%

**Table 1 Patients characteristics and lesions**

| Variables | All patients (*N*=21) |
|---|---|
| Age | |
| Mean±SD | 51±9.5 |
| Range | 36–65 |
| Sex | |
| Male | 12 (57.1) |
| Female | 9 (42.9) |
| Comorbidities | |
| Smoking | 7 (33.3) |
| Hypertension | 17 (81) |
| Diabetes | 15 (71.4) |
| Coronary disease | 4 (19.1) |
| Type of lesion | |
| Stenosis | 9 (42.9) |
| Occlusion | 12 (57.1) |
| Site of lesion | |
| Cephalic lesion | 1 (4.8) |
| Axillary vein lesion | 2 (9.5) |
| Subclavian vein lesion | 4 (19.1) |
| Brachiocephalic lesion | 12 (57.1) |
| Combined | 2 (9.5) |

Quantitative data were expressed as mean±SD and range or *n* (%).

**Figure 1**



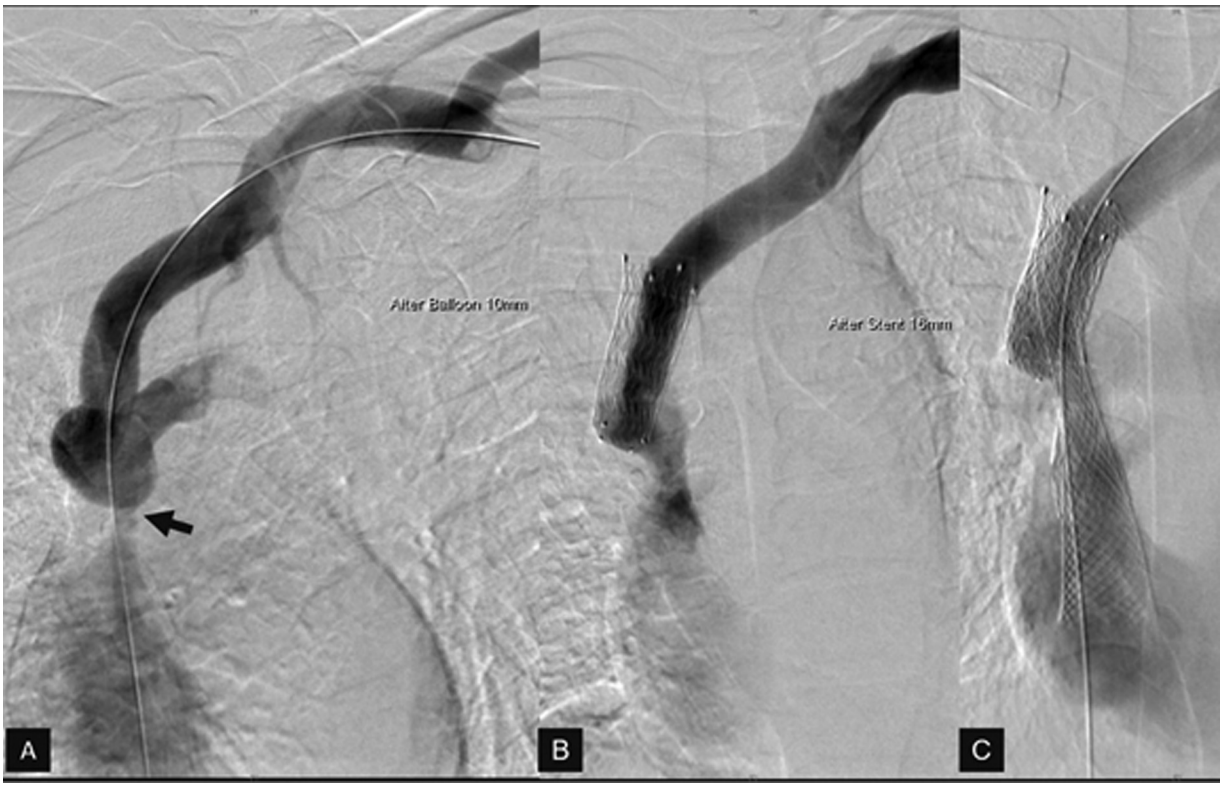

A 45-year-old man with venography showing tight stenosis (arrow) at the caudal segment of left brachiocephalic vein (BCV) (a). Dilatation using 10×60 mm balloon shows the waist that corresponds to the maximum point of narrowing (b). Restoration of the left BCV diameter (c).

right side), axillary vein in two (9.5%) patients (50% right side), subclavian vein in four (19.1%) patients (75% right side), brachiocephalic vein in 12 (57.1%) patients (41.7% right side) and in two (9.5%) patients (50% right side) the lesions were combined. The lesions were occlusion in 12 (57.1%) patients and significant stenosis in nine (42.9%) patients. The mean lesions length was 4.5±1.5 cm (range: 2–7 cm) (Table 1).

Technical success (resolution of edema and preserving the access) occurred in 17 (81%) patients. PTA was done in 12 patients as the patient shown in Fig. 1. Stenting was done in five patients (the obstruction persisted in spite of PTA in two patients (as the patients shown in Figs 2 and 3) and extravasation in two patients and dissection in one patient). We failed in four patients (one patient of subclavian vein occlusion and three patients of brachiocephalic vein occlusion) in whom ligation of the access was done.

Early complications occurred in three (14.3%) patients in the form of dissection in one patient, and limited contrast extravasation in two patients, and these complications were successfully managed by stenting. Late complications occurred in five (23.8%) patients within 4–10 months in the form of restenosis with recurrence of limb swelling in four patients (the first patient at 4 months and was successfully managed by re-PTA, the second and third patients at 5 and 7

**Figure 2**




A 52-year-old man with venography showing tight stenosis at the left brachiocephalic vein (BCV) superior vena cava (SVC) junction (arrow) that did not respond to percutaneous transluminal angioplasty (a). A stent of 16×40 mm was deployed. Unfortunately, the stent migrated upwards (b). Another 18×80 mm stent was deployed to overcome this tight segment (c).

months and stenting failed in them and the fourth patient was successfully managed by a covered stent (Viabahn) (W.L. Gore & Associates Inc., Flagstaff, Arizona, USA) for extravasation (Fig. 4) and thrombosis of the access in one patient (was managed conservatively and continued hemodialysis by contralateral permcath) (Table 2). Mean intervention-free period was 5.1 months.

Three patients died during follow-up at 3, 5, and 8 months after the intervention. These patients had associated co-morbidities in the form of dilated cardiomyopathy, myocardial infarction and malignancy, respectively.

The initial success rate of endovascular interventions was 81%. Table 3 shows the primary patency rates (70.1% at 6 months and 53.5% at 12 months, respectively) and expressed as Kaplan–Meier plot in Fig. 5. Table 4 shows the secondary patency rates (75.3 and 63.9% at 6 and 12 months, respectively) and expressed as Kaplan–Meier plot in Fig. 6.

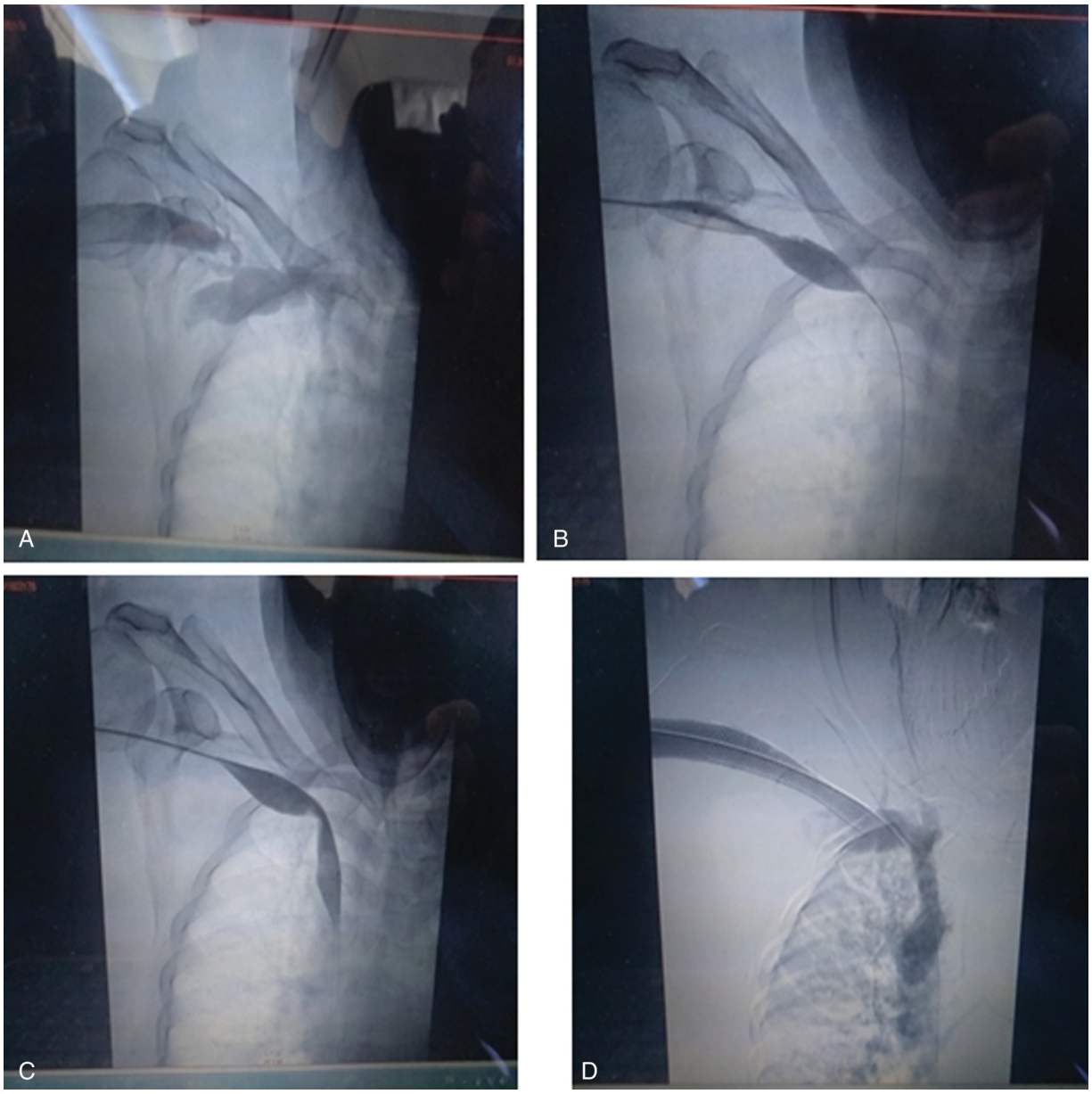
## Discussion

Central venous catheter insertion is one of the main predisposing factors of CVO. The incidence of subclavian vein obstruction due to catheter insertion is 12–29% [1,3,4] and internal jugular vein obstruction is 5% of patients [3].

This study included 21 (12 men and nine women) patients. The mean age was 51±9.5 years (36–65 years). Eleven patients had involvement of the right-sided venous system and 10 patients had involvement of the left side. The lesions were in the Proximal cephalic vein in one (4.8%) patient (100% right side), axillary vein in two (9.5%) patients (50% right side), subclavian vein in four (19.1%) patients (75% right side), brachiocephalic vein in 12 (57.1%) patients (41.7% right side), and in two (9.5%) patients (50% right side) the lesions were combined. The lesions were occlusion in 12 (57.1%) patients and significant stenosis in nine (42.9%) patients. The mean lesion length was 4.5±1.5 cm (range: 2–7 cm).

A study done by Shi *et al.* [4] which included 24 (18 men and six women) patients with mean age of 66.4 ±13.8 years. The lesions were significant stenosis in 10 patients (subclavian vein in two patients and brachiocephalic vein in eight patients) and occlusion in 14 patients (brachiocephalic vein in seven patients and combined long occlusions in seven patients).

**Figure 3**



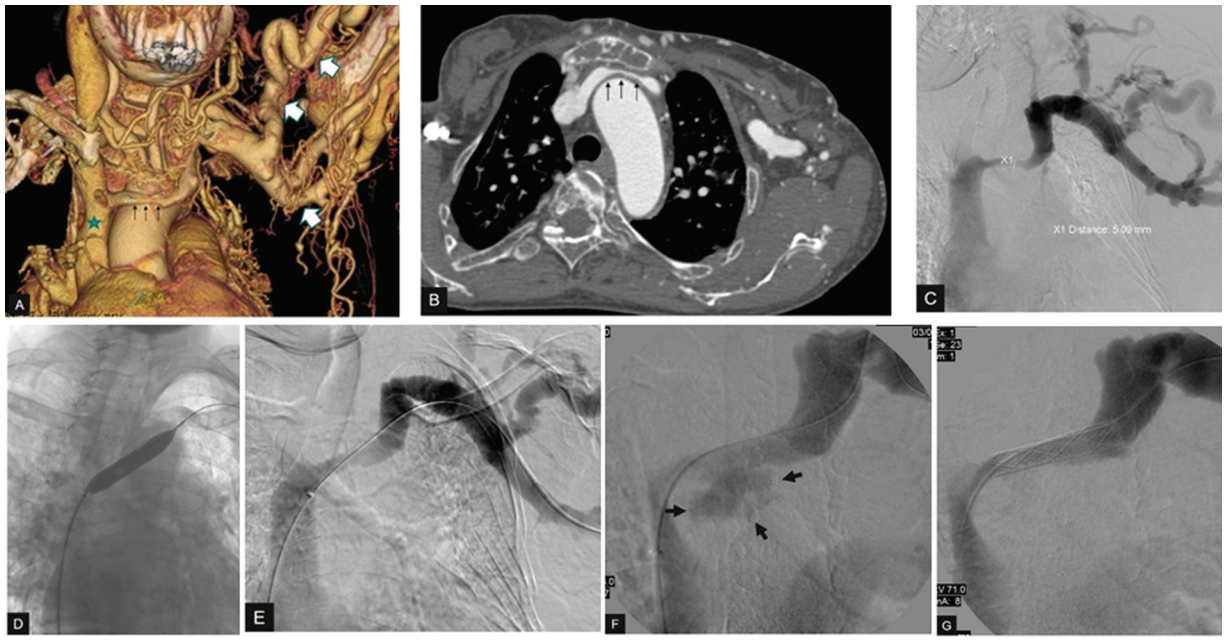

A 60-year-old woman with venography showing stenosis of both the caudal segment of right cephalic vein and the right brachiocephalic vein (BCV) (a). Gradual percutaneous transluminal angioplasty with 12×40 mm, 14×60 mm balloons (not shown) and 16×60 mm balloons (shown) (b, c). A 16×60 mm stent was deployed at the cephalic subclavian junction (d).

In this study, the initial technical success rate was 81% which was the same as in a study done by Yadav *et al.* [5] 82%, but lower than that in studies done by Dammers *et al.* [6] and Vogel *et al.* [7] at which the initial technical success rate was 96%.

In this study restenosis occurred in four (19.1%) patients within 4–10 months and the mean intervention-free period was 5.1 months, which was higher than that in a study done by Yadav *et al.* [5] which was 14% within 2–5 months and the mean intervention-free period was 3.5 months, and is lower than that of a study done by Dammers *et al.* [6] at which restenosis was 22% within 3.7–7.5 months and the mean intervention-free period was 4.8 months.

In this study, PTA was done in 12 patients and stenting was done in five patients (the obstruction persisted in spite of PTA in two patients, extravasation in two patients and dissection in one patient). And during follow-up restenosis occurred in four patients (the first patient at 4 months and was successfully managed by re-PTA, the second and third patients at 5 and 7 months and stenting failed in them and the fourth patient was successfully managed by a covered stent for extravasation). The primary patency rates at 6 and 12 months were 70.1 and 53.5%; and secondary patency

**Figure 4**



A 39-year-old woman with computed tomographic venography (CTV) showing stenosis of the left brachiocephalic vein (BCV) (arrows) with extensive collaterals and dilated upper limb veins (block arrows) (a, b). Venography confirmed CTV findings (c). percutaneous transluminal angioplasty (PTA) with 10×40 mm balloon (d) yielded good results (e). Eight months later, symptoms recurred, gradual PTA with 10, 12 and 14 mm balloons (not shown) however, the patient experienced severe chest pain due to contrast extravasation (arrows) (f) therefore, a 13×50 mm covered stent (Viabahn) was deployed (g).

**Table 3 Life table analysis of primary patency rate of endovascular interventions**

| Interval (months) | At risk grafts | Failed during interval | Withdrawn during interval | Interval failure rate | Cumulative patency rate | Standard errors |
|---|---|---|---|---|---|---|
| 0–3 | 21 | 4 | 1 | 19.5 | 80.5 | 7.7 |
| 3–6 | 16 | 2 | 1 | 12.9 | 70.1 | 9.5 |
| 6–9 | 13 | 2 | 1 | 16 | 58.9 | 10.4 |
| 9–12 | 11 | 1 | 0 | 9.1 | 53.5 | 11 |

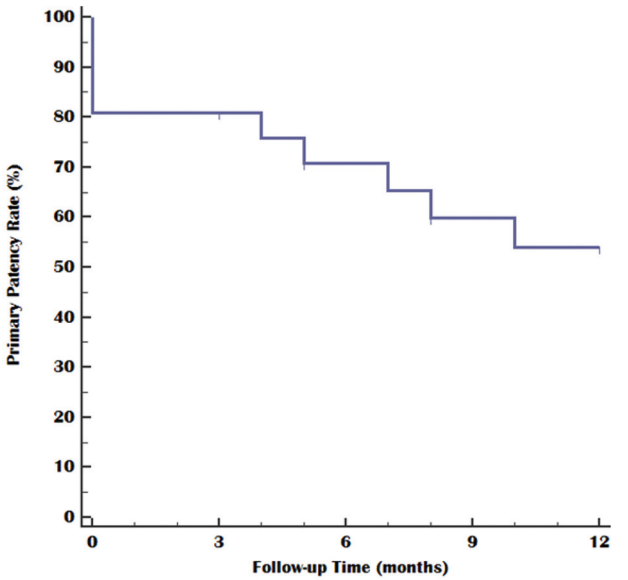
**Table 2 Complications**

| Types | All patients (*N*=21) [*n* (%)] |
|---|---|
| Early complications | 3 (14.3) |
| Extravasation | 2 (9.5) |
| Dissection | 1 (4.8) |
| Late complications | 5 (23.9) |
| Access thrombosis | 1 (4.8) |
| Restenosis | 4 (19.1) |

rates at 6 and 12 months were 75.3 and 63.9%, respectively.Several studies had used PTA with or without stenting. Some authors recommend primary stenting over PTA [8]. Many authors recommend primary stenting in recurrent stenosis as Aytekin *et al.* [9] and Chen *et al.* [10] and in these studies the initial success rate was 100% and the primary patency at 3, 6, and 12 months was 100, 89, and 56%, respectively.

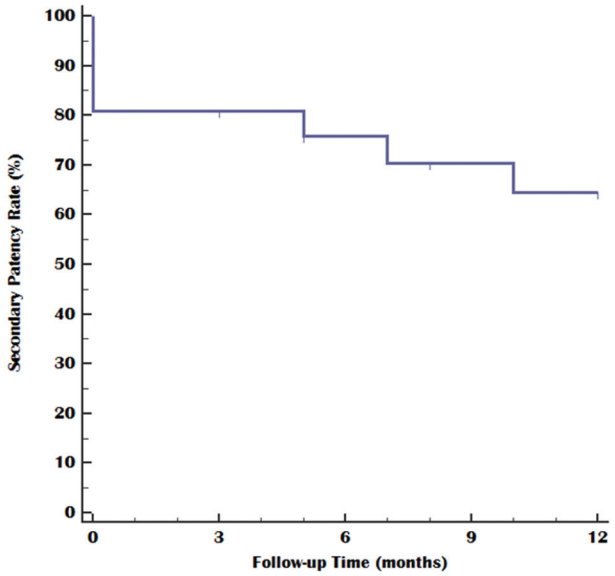
In a study done by Quinn *et al.* [11] at which 18 stents were deployed, primary patency rates were at 3, 6, and 12 months: 40, 32, and 32%; and

**Figure 5**




Kaplan–Meier plot of primary patency rate of endovascular interventions.

**Figure 6**




Kaplan–Meier plot of secondary patency rate of endovascular interventions.

**Table 4 Life table analysis of secondary patency rate of endovascular interventions**

| Interval (months) | At risk grafts | Failed during interval | Withdrawn during interval | Interval failure rate (%) | Cumulative patency rate (%) | SE (%) |
|---|---|---|---|---|---|---|
| 0–3 | 21 | 4 | 1 | 19.5 | 80.5 | 7.7 |
| 3–6 | 16 | 1 | 1 | 6.5 | 75.3 | 9.3 |
| 6–9 | 14 | 1 | 1 | 7.4 | 69.7 | 10.2 |
| 9–12 | 12 | 1 | 0 | 8.3 | 63.9 | 11.1 |

secondary patency rates at 3, 6, and 12 months were 70, 55, and 39%, respectively, and another study was done by Bakken *et al.* [12] in which the primary patency rates at 3, 6, and 12 months were 72, 55, and 46%.

In a study done by Shi *et al.* [4], they did not find any significant difference between the PTA group and stenting group regarding primary or secondary patency.

## Conclusion

Endovascular management of CVO can be used safely in CRF patients with good results at the short run, but for long run results, regular follow-up and reinterventions are mandatory. Decreasing insertion of central venous catheters, especially in the subclavian vein, is the main prophylaxis against CVO.

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Nil.

**Conflicts of interest**

There are no conflicts of interest.

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