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Herzallah A. M. Assem Mohamed
Mataria Teaching Hospital

Mohamed T. Yousuf
Mataria Teaching Hospital, drmohtaha66@yahoo.com

Mohamed M. Gouda Wahdan
Mataria Teaching Hospital

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Original Article

Endovascular intervention for symptomatic complete central venous occlusion in hemodialysis patients

Herzallah A. M. Assem Mohamed, Mohamed T. Yousuf, Mohamed M. Gouda Wahdan

Department of Vascular Surgery, Mataria Teaching Hospital, Cairo, Egypt

Abstract

Background

Centralven ous occlusion (CVO) is a common complication in hemodialysis patients, causing significant morbidity and arteriovenous fistula (AVF) dysfunction. CVO occurs in ~25–40% of hemodialysis patients. CVO most commonly occurs as a result of endovenous scarring secondary to repeated central venous catheterizations. The aim of the endovascular intervention is to provide symptomatic relief to the patients while preserving the function of AVF.

Objective

The aim of this study was to evaluate the efficacy and safety of endovascular intervention for central venous obstruction (CVO) in hemodialysis patients.

Patients and methods

This prospective study included 17 hemodialysis patients with symptomatic complete CVO on the side of a functioning AVF, who underwent endovascular intervention between January 2016 and December 2018 in Mataria Teaching Hospital, Cairo, Egypt.

Results

The study was conducted on 17 hemodialysis patients, comprising 13 (76.5%) females and four (23.5%) males. Their age ranged between 51 and 69 years, with a mean age of 60 years. Successful recanalization was achieved in 12 (70.6%) patients, and inability to cross the lesions occurred in five (29.4%) patients. The follow-up period ranged from 7 to 17 months, with the mean overall follow-up was 13.5 months. The primary patency rate was 100% at 6 months. Recurrent stenosis occurred in two (16.6%) patients, and the two patients were subjected to a second successful endovascular intervention.

Conclusion

Endovascular intervention is safe and effective in treating central venous obstruction in hemodialysis patients.

Keywords: Angioplasty, central venous obstruction, endovascular intervention, hemodialysis patients

Introduction

Central venous occlusion (CVO) is a common complication in hemodialysis patients, causing significant morbidity and arteriovenous fistula (AVF) dysfunction. CVO occurs in ~25–40% of hemodialysis patients [1]. CVO most commonly occurs as a result of endovenous scarring secondary to repeated central venous catheterizations [2]. It is often the end stage of a repeated manipulation and scarring cycle that is ultimately mediated by intimal hyperplasia and fibrin sheath development [3].

The main causes of central venous obstruction in hemodialysis patients are prolonged central venous catheterization for hemodialysis and the high-flow states associated with hemodialysis AVFs, which subsequently cause central venous intimal hyperplasia and stenosis or occlusion [4].

Correspondence to: Mohamed T. Yousuf,
Alshrouk City, Megawra 5, Number 89, Cairo 11837, Egypt,
Tel: 00201001676488.
E-mail: drmohtaha66@yahoo.com

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CVO in hemodialysis patients with ipsilateral AVF is usually manifested by severe arm and chest wall edema and pain, and using the access site for dialysis typically exacerbates edema in these patients [5]. CVO in these patients endangers the function of the vascular access and results in significant morbidity of the patient [6]. Different treatment entities have been used to correct central venous lesions, including endovascular procedures and surgical reconstruction. Although high primary patency rates (80–90% at 1 year) have been reported with open surgical repair of the central veins, it carries a high rate of postoperative morbidity and mortality [2]. Endovascular management has been widely accepted as the modality of choice for treatment of CVO [7]. The National Kidney Foundation Disease Outcomes Quality Initiative guidelines [8] have recommended endovascular treatment with percutaneous transluminal angioplasty (PTA), with second-line stent placement as the preferred treatment approach to CVO. Successful recanalization or reconstruction of a chronically occluded vein requires access across the damaged area. However, crossing of the occluded segment with guidewires and catheters is technically challenging because the vein lumen is often destroyed by chronic thrombosis and fibrosis [9]. Endovascular treatment options include PTA, bare-metal stent, or covered stent placement. The optimal endovascular treatment, however, remains unclear, with no clear advantage of primary stent placement in comparison with balloon angioplasty alone [10].

Aim

The aim of this study was to evaluate the efficacy and safety of endovascular intervention for CVO in hemodialysis patients.

Patients and methods study design

This is a prospective study.

The study was approved by the Ethics Board of Vascular Surgery Department, Mataria Teaching Hospital, Cairo, Egypt.

Study population

A total of 17 hemodialysis patients with symptomatic complete CVO on the side of a functioning AVF underwent endovascular intervention for the central veins. All the patients were on hemodialysis for chronic renal failure. Mean duration of dialysis before the intervention was 3.7 years (range, 11 month–5.7 years). All the patients had autogenous AVF for dialysis access. Indications for treatment were excessive swelling in the arm, decreasing flow during dialysis session, and prolonged bleeding after cannulation.

Study venue

The study was conducted at Mataria Teaching Hospital, Cairo, Egypt.

Study duration

The study was conducted between January 2016 and December 2018 with a follow-up period of up to 17 months.

Preoperative assessment

Patients underwent full history taking and detailed examination. A significant subgroup of patients will have a history of previous central venous catheter placement and will present with ipsilateral arm, breast, face, or neck swelling (Fig. 1). Depending on the location of the access, a proportion of patients will have evidence of AV access dysfunction with decreased access flow or aneurysmal dilation of the fistula. On physical examination, there may be numerous dilated collateral veins in the neck or chest and arm edema on the side of the CVO.

Duplex ultrasound

Although it is difficult to visualize the central veins with duplex ultrasound, CVO can sometimes be diagnosed by duplex ultrasound by the absence of normal respiratory variation in the diameter of central veins and polyphasic atrial waves, so all patients were subjected to duplex examination to the neck, upper limbs including the AVF, and lower limbs, for diagnosis, planning for the access to the central veins, and to exclude acute venous thrombosis.

Computed tomography venography

Preprocedure contrast-enhanced computed tomography was done in some patients for objective documentation for the extent of lesions, but computed tomography venography can underestimate the degree of stenosis. Although digital subtraction venography is the current gold standard for the diagnosis of CVO, extensive collateral vessels are sometimes the only indication of an underlying CVO.

A written informed consent for the procedure and for the study was taken from all patients.

Technique

Procedure

In all patients, a preliminary diagnostic venography was performed with digital subtraction angiography (DSA). Location, length, and extent of stenosis/occlusion were assessed. Endovascular interventions were performed in the same sitting. Venous access was obtained in all cases at first by antegrade venous puncture of the fistula vein (cephalic vein in 12 cases and basilic vein in five cases). A combined approach using both cephalic or basilic and common femoral veins was used in eight cases. Femoral venous puncture was used to obtain access in difficult cases. Recanalization usually was attempted with an upper arm venous approach using a hydrophilic-coated, steerable, 0.035-inch guide wire and a 4-F Bern catheter after securing the access by a

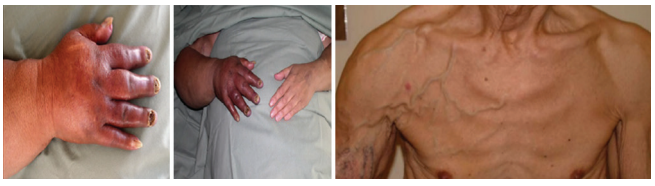

Figure 1: Presentation of central veins obstruction.

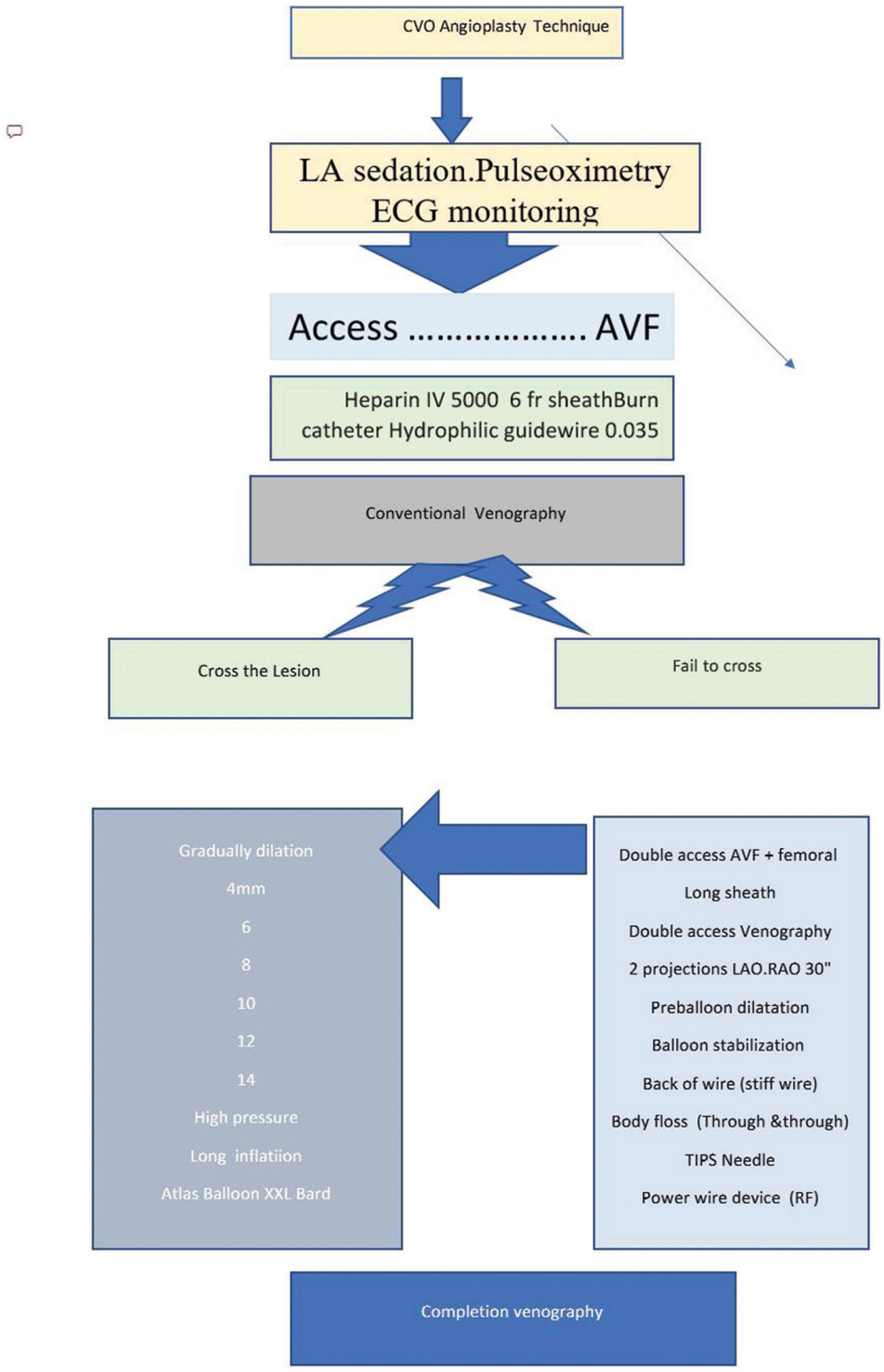

Figure 2: Basic and advanced techniques of PTA techniques for CVO. CVO, central venous occlusion; PTA, percutaneous transluminal angioplasty.

short 7-F sheath. A long sheath was used in cases of femoral approach (Fig. 2).

After crossing the lesion, the hydrophilic guidewires were sometimes replaced by stiff guidewires, and PTA was performed subsequently. Serial dilations starting with a small balloon diameter (usually a 4-mm-diameter balloon) followed by increasing diameters. PTA balloon diameter ranged from 10 to 14 mm, with burst pressures between 20 and 25 atmosphere. Length of the balloons ranged from 4 to 8 cm. A balloon having diameter of 1–2 mm larger than the adjacent normal vein was selected, and angioplasty was done by inflating the balloon for 5 min (Fig. 3). For some

hard obstructing lesions, the stiff end of the guide wire was also used.

Stenting was performed if greater than 30% residual stenosis was present after repeated PTA or if recurrent stenosis occurred within 3 months.

Technical success was defined as procedure without significant residual stenosis or without complications.

Technical failure was defined as inability to cross/dilate the lesion or significant residual stenosis (>30%).

Challenging lesions

For occlusions that cannot easily be crossed, some extra methods were utilized (Fig. 4):

(1) Double-access venography.
(2) Double-access recanalization.
(3) Double projection.
(4) Preballoon dilatation.
(5) Balloon stabilization technique.
(6) Sharp recanalization (back of the wire).
(7) Body Floss method (through and through).

Postoperative

All patients were discharged on the following day.

All patients were completely anticoagulated by warfarin after bridging with heparin, keeping INR 2–3.

Results

A total of 17 patients underwent 19 interventions for endovascular treatment of CVO. The study comprised 13 females and four males, with a mean age of 60 years (51–69 years). The baseline characteristics of the study patients are shown in Table 1.

A total of 12 patients had occlusion of the left innominate vein, three patients had left subclavian vein occlusion, and two patients had occlusion of the right innominate vein. Angiographic characteristics of the study patients after digital subtraction angiography are shown in Table 2.

Percutaneous transluminal angioplasty outcomes

Technical success was achieved in 70% (12/17) of cases. In five patients, the occluded segment could not be crossed. The inability to cross the lesions in these five patients was related to the accompanying criteria: (a) long occluded segment (>5 cm) and (b) flush innominate vein occlusion with no nipple to help wire advancement.

In the failed cases, ligation of the fistula was done with creation of a contralateral access.

In two cases, PTA was followed by stent placement in the same setting owing to remaining stenosis more than 30% following angioplasty. The diameter of the stent was the same as the adjacent normal vein. In the two cases, self-expanding bare-metallic stents (Protégé, Medtronic) were used. Stent diameters were 12 mm, with 6 cm length.

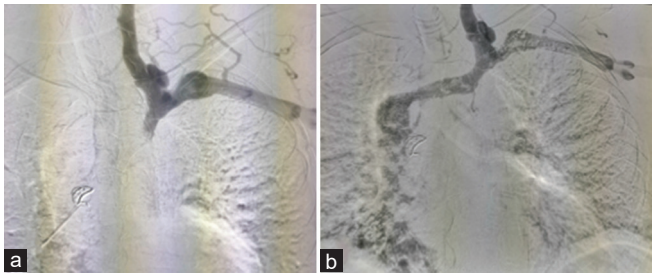

Figure 3: A 61-year-old female patient with left brachiocephalic AVF presented with swelling of left arm, left breast, and face. (a) Initial diagnostic venogram showed complete occlusion of left innominate vein with presence. AVF, arteriovenous fistula. (b) Post PTA venogram showed normal filling of left Innominate vein

Table 1: The characteristics of the study patients

	n (%)
Number of patients	17
Number of interventions	19
Age (years) (mean±SD)	60±9
End-stage renal disease	17 (100)
Ipsilateral functioning AVF	17 (100)
Female sex	13 (76.5)
Male sex	4 (23.5)
Hypertension	15 (88)
Past history of ipsilateral neck hemodialysis catheter	17 (100)

AVF, arteriovenous fistula.

Table 2: Digital subtraction angiography findings of the study patients

	n/*N* (%)
Left innominate vein occlusion	12/17 (70)
Left subclavian vein occlusion	3/17 (18)
Right innominate vein occlusion	2/17 (12)

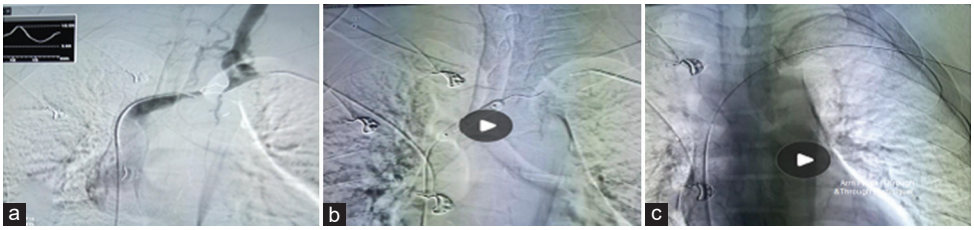

Figure 4: Advanced techniques of PTA techniques for CVO. (a) Double-access venography showing total occlusion of left innominate vein. (b) Balloon stabilization technique. (c) Body floss (through and through) technique. CVO, central venous occlusion; PTA, percutaneous transluminal angioplasty.

The follow-up period ranged from 7 to 17 months, with the mean overall follow-up of 13.5 months. Primary patency rate was 100% at 6 months. Recurrent stenosis occurred in two (16.6%) patients after 7 and 9 months, and the two patients were subjected to a second successful endovascular intervention. No major periprocedural morbidity or mortality occurred, but local extravasation occurred in three cases and was the cause to abort the intervention, and hemothorax happened in one case, and intercostal tube was inserted and the patient was discharged well.

Angioplasty short-term and long-term outcomes of the study patients are shown in Table 3.

Discussion

CVO in hemodialysis patients is a common complication that may occur after placement of large-bore hemodialysis central venous catheters, especially if the catheter is in subclavian vein. Catheters placed in subclavian veins have a high risk, with a 42% incidence of central venous disease (CVD) compared with a 10% rate in internal jugular vein [11], so the Dialysis Outcome and Quality Initiatives (DOQI) guidelines have advocated avoiding catheterization of subclavian vein for obtaining temporary access in patients with chronic renal failure [8]. There is also an increased predilection for CVD to occur with left-sided venous access catheter placement [12]. Another important factor in the development of CVO is the hemodynamic stress secondary to high flow of the associated hemodialysis AVF [13]. Most patients with CVO secondary to central venous catheters are most commonly asymptomatic, and the disease clinically declares itself after a hemodynamic change such as the placement of an ipsilateral AV access for hemodialysis [9]. The presence of an ipsilateral vascular access greatly increases the blood flow in an upper extremity, such that 70% of patients who have an ipsilateral hemodialysis access will become symptomatic with a CVO as compared with the 10% of nondialysis patients who become symptomatic [4].

CVO affects the hemodialysis access by causing symptomatic venous hypertension and access flow dysfunction, but CVOs are rarely the cause for access thrombosis owing to the fact that most of the patients develop collateral circulation. The incidence of CVD in hemodialysis patients has been reported in the literature to be in the range of 25–40% [14].

Table 3: Short-term and long-term outcomes of the study patients

	n/N (%)
Successful recanalization	12/17 (70)
Failed recanalization	5/17 (30)
Balloon dilatation only	10/17 (59)
Balloon dilatation and stenting	2/17 (12)
Primary patency after 6 months	12/12 (100)
Primary patency after 9 months	10/12 (83.3)
Reintervention	2/17 (12)
Secondary patency	2/2 (100)
Minor complications	4/17 (23.5)
Mortality	0/17

Symptoms secondary to CVO depend on the anatomical site of the stenosis or occlusion. A narrowing or occlusion of the subclavian vein most commonly presents with AV access dysfunction or ipsilateral edema of the extremity and breast. Brachiocephalic vein stenosis or occlusion affects blood flow from the same side of the face as well as the upper extremity and breast, leading to ipsilateral extremity and possible facial and neck edema [15].

Ligation of the functioning fistula is the simplest symptomatic therapy to relieve limb edema, which, however, sacrifices the hemodialysis access. The initial management was open surgical repair of the central veins, and despite having high primary patency rates at 1 year of 80–86%, surgical methods carried high morbidity and mortality, so traditional surgical bypass is reserved as the last option for CVO patients who are refractory to endovascular intervention [16]. Endovascular intervention is the first line of treatment in hemodialysis patients with CVO. The treatment options include PTA, placement of bare-metal stents, and recently, covered stents. The Kidney Disease Outcomes Quality Initiative guidelines recommend endovascular treatment with PTA with second-line stent placement as the preferred treatment approach to CVO [8]. However, chronically occluded veins are often difficult to cross using guidewires and catheters, with some reported failure rates. The difficulty in recanalizing and maintaining a patent CVO occurs from the process of endothelialization, smooth muscle cell proliferation, and extracellular matrix prevalence [17].

In this study, 17 hemodialysis patients with symptomatic complete CVO on the side of a functioning AVF underwent endovascular intervention for the central veins. In patients with asymptomatic, acute onset or incomplete CVO, we considered intervention is not indicated because waiting a few weeks may allow development of sufficient venous collaterals that reduce symptoms with minimal access dysfunction. If there are minimal elevated venous pressures or recirculation, we prefer to avoid intervention unless a nephrologist considers these problems to be major, taking into consideration the limited patency and potential acute and chronic complications of the intervention.

Technical success was achieved in 70% (12/17) of cases. Our results are consistent with other studies such as those of Modabber and Kundu [18] and Krycinska *et al.* [19]. They reported technical success rates of PTA for CVO from 70 to 100%. Other studies reported technical success rate ranging from 70 to 90% for PTA without stenting [14,20–22] and very high technical success rates for PTA and stenting, ranging from 90 to 100% [7,23–26].

Although the present study is a prospective study, some limitations can be identified. This study is a single-center

experience with a relatively small study population with a short-term follow-up period. Further multicenter studies with large numbers of patients and with long-term follow-up periods are required to confirm the current results.

Conclusion

Endovascular intervention is safe and effective in treating CVO in hemodialysis patients.

Endovascular intervention can improve the occlusion and alleviate the symptoms, but CVO typically recurs frequently, requiring repeated interventions. Refractory symptomatic CVO may require ligation of the ipsilateral AVF. Because no available treatment option is curative, the goal should be to prevent CVO by minimizing central venous catheters in hemodialysis patients.

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Conflicts of interest

There are no conflicts of interest.

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