

Long-term outcomes of stenting superior cava and brachio-cephalic vein occlusion in hemodialysis patients with arteriovenous fistulas

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ABSTRACT

Objective: Central vein occlusion (CVO) is a significant complication in patients undergoing chronic hemodialysis, often leading to dialysis inefficacy, disabling symptoms, and, most critically, major risk of access failure. Although stenting has been proposed as a technique to maintain vascular access patency following the recanalization of occluded central veins, the data supporting its long-term efficacy remains limited. This study aims to evaluate the long-term effectiveness of stenting occluded superior vena cava (SVC) and/or brachiocephalic veins to preserve vascular access patency, ensure continued dialysis efficacy, and relieve SVC syndrome.

Methods: This study retrospectively reviewed all hemodialysis patients who underwent stent placement for CVO between January 2017 and August 2024 at two vascular centers in Reunion Island. The primary endpoints of the study were the primary, assisted primary, and secondary patency rates of the vascular circuit during follow-up. Additionally, patient demographics, medical comorbidities, postoperative complications, definitive access abandonment, and reinterventions were analyzed.

Results: This study included 21 patients with a mean age of 67 years. CVO stenting initially provided symptomatic relief for all patients, resolving symptoms such as SVC or arm swelling in symptomatic patients. Over a median follow-up period of 41 months (range, 3-80 months), the primary patency rates were 67% at 12 months, 42% at 24 months, and 38% at 36 months, whereas the secondary patency rates were 90%, 79%, and 60% at these same intervals. Twelve patients (62%) experienced clinically significant stent restenosis, necessitating one or several additional percutaneous transluminal angioplasties during follow-up, whereas five patients (24%) developed acute access thrombosis requiring thrombectomy and percutaneous transluminal angioplasty, with central stent involved for three patients. Three patients (14%) required extra-anatomic bypasses due to definitive stent occlusion, five patients (14%) had definitive access failure, and five patients (24%) died from unrelated causes.

Conclusions: This review suggests that hemodialysis patients with symptomatic CVO can often be successfully recanalized and treated with stenting, leading to symptom resolution and, importantly, achieving promising secondary patency rates. Our long-term results highlight the necessity for regular reintervention and close follow-up, as a significant number of patients will experience restenosis, and ultimately definitive access failure. Therefore, CVO stenting should be considered a temporary solution, although for some patients, this strategy may prove highly effective, maintaining long-term patency without any restenosis.

Clinical Relevance: We studied central vein stenting for 21 hemodialysis patients with a mean follow-up of 41 months. Long-term results showed primary and secondary patency rate of 38% and 60% at 36 months. Twelve patients needed at least one reintervention, whereas five patients developed access thrombosis. Three patients required extra-anatomic bypasses, five patients had access failure, and five patients died. Hemodialysis patients with symptomatic occlusion of the superior vena cava or brachiocephalic vein can be successfully recanalized and stented, leading to symptom resolution and, notably, an encouraging secondary patency rate with efficient dialysis. However, a majority of patients will require multiple reinterventions including endovascular percutaneous transluminal angioplasty or extra-anatomical bypass due to symptomatic in-stent restenosis and thrombosis, and a significant number will experience definitive access failure. Central venous obstruction stenting is a valuable initial strategy but should only be performed without compromising further access, as it represents a salvage procedure with important risk of failure during prolonged follow-up. (*J Vasc Surg Venous Lymphat Disord* 2025;13:102007.)

Keywords: AVF; Cava; Central; CVO; Dialysis; Fistula; Occlusion; Stent; Stenting; Syndrome; Vein

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The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2213-333X

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<https://doi.org/10.1016/j.jvsv.2024.102007>

Central venous occlusive disease (CVOD) is a common problem in the hemodialysis population, contributing significantly to morbidity, as it may disrupt dialysis efficiency by causing venous hypertension, prolonged post-dialysis bleeding, and debilitating symptoms such as facial swelling, arm swelling, and headaches.¹ Up to 4% to 6% of patients on hemodialysis may experience CVOD. Moreover, CVOD may cause arm and face swelling, difficult puncture, prolonged bleeding, and finally, arteriovenous fistula (AVF) dysfunction, which could endanger the patient's life by causing a temporary or permanent loss of vascular access.² Multiple factors have been identified as contributing to the onset and progression of this pathology.^{2,3} The principal mechanism is venous intimal hyperplasia, caused by endothelial damage from central catheter for temporary access and turbulent blood flow from the arteriovenous access.⁴ The incidence of central vein occlusion (CVO) has increased significantly over the past decade due to an increase in the use of temporary dialysis catheters. The management of CVOD includes open surgery, endovascular treatment by percutaneous transluminal angioplasty (PTA), bare metal stent (BMS) placement, and mostly, covered stent (CS) placement with less restenosis.⁵⁻¹⁰ Due to their ability to stabilize the lumen against recoil and prevent the development of intimal hyperplasia, stents have been shown in recent studies to be superior to angioplasty alone in terms of patency and rate of secondary interventions.^{6,9-12} However, the optimal therapeutic strategy remains uncertain due to the limited experience documented in stenting central venous occlusive lesions, which is largely based on small case series.⁵⁻¹² Additionally, the long-term outcomes of patients requiring central vein stenting are unclear, as no studies have reported extended follow-up results.

MATERIAL AND METHODS

We searched for all chronic hemodialysis patients requiring endovascular stenting of central vein thrombosis, for dialysis inefficiency or superior vena cava (SVC) syndrome between January 2017 and August 2024 in two major hemodialysis care centers of Reunion Island: CHU Sud Réunion and Clinique Sainte Clotilde. We conducted a retrospective search in 2022 for all patients that received a stent in the central vein; they were followed-up during the study period until July 2024. Institutional Review Board approval was not required for this retrospective, observational, and consequently noninterventional studies. We adhered to ethical standards, and all patients included provided written consent. Patients that received a central stent during the study period after the retrospective search were also included and followed. Inclusion criteria were: (1) patients with patent AVFs requiring endovascular intervention due to access dysfunction or symptoms linked to central vein thrombosis; (2) SVC or brachiocephalic vein (BCV) thrombosis

ARTICLE HIGHLIGHTS

- **Type of Research:** Multicenter prospective cohort, with retrospective research of patients, retrospectively collected data, and prospective inclusion of patients and data after the initiation of the study
- **Key Findings:** We included 21 patients with central vein stenting for hemodialysis with a mean follow-up of 41 months. Long-term results showed primary and secondary patency rate of 38% and 60% at 36 months, respectively. Twelve patients needed at least one reintervention, whereas five patients developed access thrombosis. Three patients required extra-anatomic bypasses, five patients had access failure, and five patients died.
- **Take Home Message:** Hemodialysis patients with symptomatic occlusion of the superior vena cava or brachiocephalic vein can be successfully recanalized and stented, leading to symptom resolution and, notably, an encouraging secondary patency rate with efficient dialysis. However, a majority of patients will require multiple reinterventions, including endovascular percutaneous transluminal angioplasty or extra-anatomical bypass due to symptomatic in-stent restenosis and thrombosis, and a significant number will experience definitive access failure. Central venous obstruction stenting is a valuable initial strategy but should only be performed without compromising further access, as it represents a salvage procedure with important risk of failure during long-term follow-up.

visualized on intraoperative angiography; and (3) placement of a stent in the target vessel. We retrospectively collected patient demographics, comorbidities, type of access, and all information about the intervention from our electronic database, at inclusion and prospectively since 2020 during follow-up. The access was assessed as patent if the patient had successful hemodialysis without clinical symptoms (bleeding, swelling, dialysis inefficacy) between check-ups. Central veins were defined as the SVC and the right or left BCV; central vein stenosis without complete thrombosis were excluded. Primary patency was defined as the time interval from initial stent placement to a new endovascular intervention involving angioplasty or stenting in the stented central vein. Secondary patency was defined as the interval from central vein stent placement to any intervention performed to reestablish the functionality of the thrombosed access. Clinical success was defined as the resolution of symptoms related to arm venous hypertension. Access failure was defined as the development of definitive thrombosis, ligation, or abandonment of the access during follow-up.

Operative protocol. The operative protocol included puncture of the fistula, with ultrasound guidance if needed, followed by the placement of a guide wire and then a 5-F sheath catheter. In cases where we were unable to cross the CVO from the arm, we opted for femoral vein puncture. A fistulography was performed from the arteriovenous (AV) anastomosis to the left cardiac atrium, identifying the CVO, whether it was in the SVC or the left or right BCV. We used various combinations of guidewires and different size and shape catheters to cross the occluded vein and then advanced a high pressure balloon to prepare the vein for stenting. The stent was selected based on the characteristics of the lesion. We used a total of 21 self expandible stents, including 19 Sinus XL (OpiMed), three Wallstents (Boston Scientific), and four CSs (Viabahn, Gore Medical). All these self-expanding stents were post-inflated to ensure optimal expansion and proper opening of the stent. Most patients (81%) received a single stent; only four patients required two stents. The mean length of the stented segment was 70 mm (range, 40-140 mm). Stenting was not performed if the deployment would have involved covering the patent contralateral internal jugular vein or the contralateral BCV, to preserve the feasibility of future fistula creation. The sheath was then exchanged for a larger one if required by the stent manufacturer. After stenting, a control angiography was performed, and the access was closed using direct sutures. Periprocedural antibiotic prophylaxis was administered in all cases, and 50 IU/kg of heparin was given intravenously before the intervention. Patients did not routinely receive anti-coagulation treatment after the procedure. All patients were discharged on the same day of the procedure or the following day, after clinical assessment.

Surveillance protocol. Surveillance was conducted at 1, 3, and every 6 months thereafter, with clinical check-ups and ultrasound monitoring. During each check-up, we verified dialysis parameters and checked for the presence of clinical symptoms related to CVO. The nephrologist in charge of the dialysis closely monitored parameters, including venous pressure and recirculation, and promptly referred the patient if any modifications were observed. Diagnostic fistulography was scheduled if any clinical signs or dialysis parameters indicated possible stenosis or thrombosis of the stent. The occurrence of events was registered in our follow-up database. Reinterventions were classified according to the type of procedure (open or endovascular), and the dates were recorded.

Statistical analysis. Descriptive statistics are reported as mean \pm standard deviation for normally distributed continuous data, whereas median and interquartile range were used for non-normally distributed continuous data. Patency rates were estimated using Kaplan-Meier analyses.

RESULTS

We included 21 patients in this analysis, and their main characteristics are detailed in the [Table](#). Overall, the mean age of the patients was 70 years (range, 45-89 years). The fistula was a proximal brachio-cephalic for nine patients (42%), a proximal brachio-basilic for five patients (23%), a prosthetic brachio-axillary bypass for four patients (19%), and a distal fistula for three patients (14%). The AVF was at the left side for 76% of the patients. Before the procedure, 16 patients (76%) had previously undergone angioplasty of the central vein, 11 patients (52%) had a history of a central dialysis catheter, and four patients (19%) had a pacemaker probe. The mean time for each intervention was 40 minutes (range, 20-90 minutes). We used the AVF access for 16 cases, concomitantly with venous femoral access for five cases. Jugular access was not used. In total, eight stents were implanted in the SVC, two in the confluence of the SVC and left BCV, eight in the left BCV, and three in the right BCV. The operative indication for recanalization and stenting was dialysis dysfunction for 34% of the patients, swelling of the arm or face (SVC syndrome) for 19%, and a combination of dialysis dysfunction and clinical symptoms for 47%. All patients had successful dialysis after stent placement, and all patients who presented with facial or arm swelling reported complete resolution within 15 days after the procedure. There were no bilateral intervention. During the median follow-up of 41 months (interquartile range, 7-80 months), the primary patency rates ([Fig 1](#)) were 67% at 12 months, 42% at 24 months, and 38% at 36 months, the primary assisted patency rates were 90%, 63%, and 56%, whereas the secondary patency rates ([Fig 2](#)) were 90%, 79%, and 60% at these same intervals.

A total of five thrombectomies (3 for left BCV, 1 for SVC, and 1 for right BCV), including four surgical thrombectomies and one thrombo-aspiration, were necessary to maintain such patency with a mean delay of 21 months (range, 1-57 months) after stenting. The central vein stenting was involved for three patients. During the whole follow-up, 12 patients (62%) developed central vein stent restenosis that caused dialysis dysfunction, plus arm swelling in eight patients, and arm swelling only in four patients. The mean number of central vein PTAs after the initial stent placement during follow-up was 3.4, with a range of 1 to 15 interventions. One patient had asymptomatic stent stenosis and received PTA based on a decreased flow detected during the Doppler check-up. Two patients needed axillo-jugular prosthetic bypasses, whereas one patient needed axillo-femoral bypass to maintain patency and dialysis efficacy after failure to recanalize the thrombosed stent. Definitive access failure occurred in five patients ([Fig 3](#)), three with left BCV stenting, one patient for SVC stenting, and one patient for right BCV stenting. We successfully performed native

Table. Patient demographics

	Patients (N = 21)
Demographics	
Age, years	67 (45-89)
Gender, male	12 (47)
Diabetes	13 (68)
Hypertension	12 (63)
Active smoking	6 (32)
Symptoms	
Access deficiency	7 (34)
Access deficiency + swelling	4 (19)
Swelling	10 (47)

Data are presented as number (%) or mean (range).

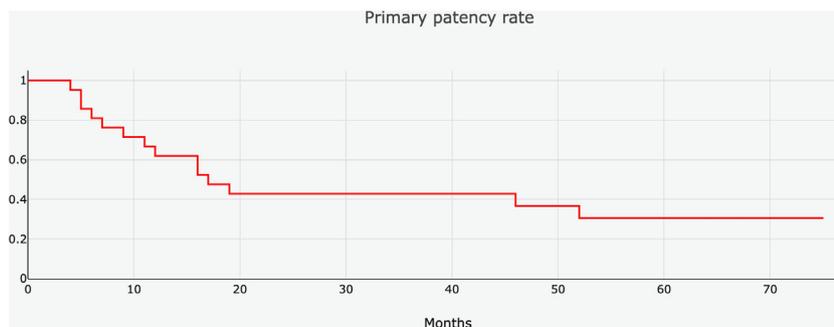
limb fistula creation for one patient, prosthetic femoro-femoral bypass for one patient, and definitive central dialysis catheter placement for three patients. Five patients died from unrelated causes: palliative care, neoplasia, or cardiac arrest.

DISCUSSION

Dialysis catheter is a major risk factor for CVO. The prevalence of CVO is increasing as more patients require hemodialysis and their life expectancy rises.¹³ Additionally, the failure to anticipate the need for hemodialysis and to plan effective access results in more patients requiring the emergency placement of dialysis catheters. Several studies have demonstrated that these catheters contribute to CVO through intimal hyperplasia, as catheterization initially traumatizes the vein, leading to a chronic inflammatory response associated with the presence of the catheter tip in the vein.⁴ The risk of occlusion is higher with direct central vein catheterization compared with jugular catheterization, and subclavian catheters should be avoided.¹⁴ Regarding these data, we suggest, in accordance with the current guidelines, to avoid the use of central dialysis catheters, especially in young patients, and to ensure early referral to a vascular surgeon for fistula creation, preventing CVO and related complications.

A lack of standardizing protocol for CVO. As CVO causes incapacitating symptoms and AVF thrombosis, it is essential to establish standardized care protocols for dialysis patients. Most of the patients of this cohort who underwent stenting for CVO had initially been treated with simple balloon angioplasty, showing that this initial treatment often resulted in restenosis, leading to complete thrombosis, likely due to increased inflammation and fibrotic reaction within the vein. Currently, the long-term outcomes of central vein stenting for occlusive disease are poorly documented. Treatment of CVO is therefore based on experience reported for central vein stenosis (CVS), including PTA and bare-metal stent (BMS) placement.⁶⁻¹⁰ PTA alone for CVS has been associated with low primary patency rates at 3, 6, and 12 months as low as 58%, 23%, and 12%, respectively. Compared with CVS, CVO exhibits significant elastic recoil after PTA, making stent placement necessary to maintain luminal patency. Indeed, stenting provides additional structural support against fibrous intimal hyperplasia and prevents immediate or early recoil after PTA.¹⁵

CVO stenting should be added to our armamentarium. To our knowledge, this is the first study to report long-term outcomes of stenting occluded central vein. Our results show primary and secondary patency rates comparable to other contemporary studies that treated CVS mixed with CVO.¹⁶ The type of stent, type of access, and the site of prosthesis deployment did not seem to affect primary patency. However, this statement is based on observational data only, as the statistical power was insufficient to make multivariable analysis with statistical assessment due to the small sample size. Despite mediocre primary patency, we report acceptable secondary patency and excellent outcomes for CVO stenting in restoring dialysis efficiency and resolving venous hypertension-related symptoms such as arm swelling, facial swelling, and headaches, without any surgical-related complications, serving as a temporary solution before definitive treatments like surgical bypass are pursued.

**Fig 1.** Kaplan-Meier curve of primary patency.

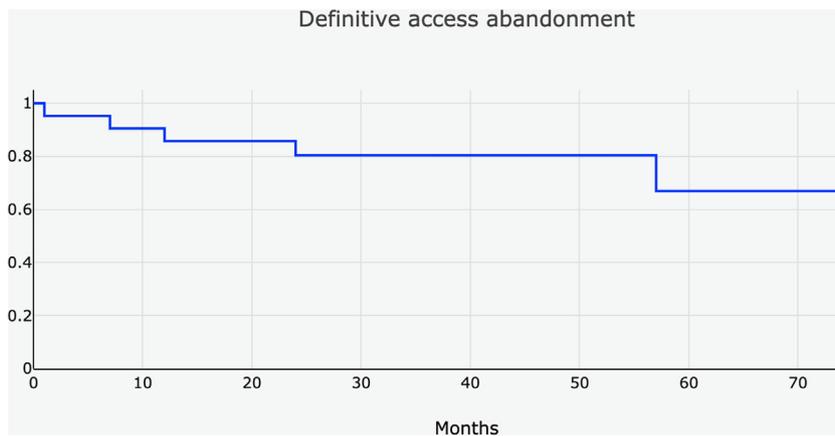


Fig 2. Kaplan-Meier curve of primary-assisted patency.

A strategy with a significant rate of failure. However, for the majority of patients, recurrent stenosis was observed during follow-up, occurring near the edge of the stent, likely due to turbulent flow caused by the angulation of the stent or compression of the stent between the sternum and the aorta. This phenomenon has also been observed in other series reported in the literature.^{17,18} In total, 67% of our patients required an at least one reintervention related to stenosis or thrombosis of the stent during follow-up. Although CVO stenting may be effective for some patients, early failure may happen, but it does not preclude other treatment options such as axillo-jugular bypass, offering a reliable solution for maintaining vascular access and dialysis efficiency. If not feasible, or if the access is definitively abandoned, patients can still undergo creation of contralateral access, native lower limb fistula via femoral vein transposition, or femoro-femoral prosthetic fistula, which has been shown to provide acceptable results. Thus, although CVO stenting is a valuable initial strategy, it also preserves the potential for subsequent interventions in case of failure, ensuring that patients have multiple pathways to maintain effective dialysis.

The need for a close follow-up and treatment planning. Given these considerations, CVO stenting must be accompanied by rigorous and regular follow-up. Angiography or computed tomography scan should be performed whenever there is suspicion of central restenosis to avoid thrombosis and loss of access.¹⁹ When considering CVO treatment in dialysis patients, it is also important to consider future access possibilities. It is crucial to avoid deploying a stent across the contralateral BCV, ipsilateral jugular vein, or dominant venous collateral vessels to preserve future access options, except when angiography shows that these vessels are already occluded.¹¹ Additionally, in patients with efficient access who present with symptoms of venous hypertension and high AVF flow, CVO may be managed conservatively with a flow reduction procedure, as collateral vessels may provide adequate outflow from the arm in the setting of reduced flow, alleviating incapacitating symptoms and venous hypertension associated with dialysis issues.

Limitations. We acknowledge that this study has several limitations that need to be mentioned. Our study population is relatively small, and we could not make precise



Fig 3. Kaplan-Meier curve of secondary patency.

statistical assessment. A total of five patients were lost to follow-up after 24 months; thus, we could not make any assessment after this date. The access was assessed patient if no events occurred during follow-up, some events may have not been recorded—even if our study centers were two major hospitals that offer hemodialysis access care on the island, patients could have received surgical intervention at a third party structure. We did not study the degree of restenosis after initial stenting for patients requiring reintervention, because the imaging was not always available. We acknowledge the possibility that asymptomatic or minimally symptomatic restenosis or rethrombosis could have been missed, despite regular medical check-ups and monitoring of dialysis parameters. Finally, we used a combination of BMSs and CSs, as several studies suggested superiority of CSs over BMSs, and our findings need to be confirmed by other studies.

CONCLUSIONS

This cohort suggests that hemodialysis patients with symptomatic occlusion of the SVC or BCV can be successfully recanalized and stented, leading to symptom resolution and, notably, an encouraging secondary patency rate with efficient dialysis. Although stenting may offer an effective solution that can last for a very long time, without the need for reintervention for some individuals, a majority of patients will require multiple reinterventions, including endovascular PTA or extra-anatomical bypass due to symptomatic in-stent restenosis and thrombosis, and a significant number will experience definitive access failure. We thus believe that CVO stenting is a valuable initial strategy but should only be performed without compromising further access, as it represent a salvage procedure with important risk of failure during prolonged follow-up. Emerging treatment options, such as drug-coated balloons, drug-eluting stents, and CSs (despite the need for larger sheaths and compromising collaterals), have shown promising early results.¹⁹⁻²¹ Larger prospective studies are needed to determine the optimal treatment strategy for these patients.

AUTHOR CONTRIBUTIONS

Conception and design: FP, RV, SD, SK, EB, GL, BD

Analysis and interpretation: FP, RV, SD, SK, GL

Data collection: SD, BD

Writing the article: FP, RV, SD, SK, EB, GL, BD

Critical revision of the article: FP, BD

Final approval of the article: FP, RV, SD, SK, EB, GL, BD

Statistical analysis: Not applicable

Obtained funding: Not applicable

Overall responsibility: FP

DISCLOSURES

None.

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Submitted Sep 24, 2024; accepted Nov 13, 2024.