Deep venous stenting in chronic iliac venous obstructive lesions: a single-center experience

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Introduction
Endovascular management for patients with chronic outflow lesions has been considered as an optimal alternative option for symptom control, as conservative compression therapy may fail later.
The study aimed to determine the clinical outcomes and to evaluate the quality of life (QoL) improvement after recanalization and deep venous stenting in patients with postthrombotic syndrome and nonthrombotic iliac vein lesion in whom conventional treatment had failed.
Patients and methods
This study was conducted prospectively on 40 patients with chronic deep venous diseases (nonthrombotic iliac vein lesion or postthrombotic syndrome) and who presented to Vascular Surgery Department, Faculty of Medicine, Assiut, Egypt from July 2016 to September 2019.
Results
A total of 40 patients with 50 limbs (21 males; median age, 45.2 years, with range, 18–75 years) were included, and all had successful recanalization and stent deployment. A complete history and physical examination were performed for all included patients as well as assessment of daily activity improvements after endovenous procedures during postoperative follow-up visits at 2 weeks, 1.5, 3, 6, and 12 months.
Deep venous recanalization with deployment of stents was medically successful in all 50 limbs with overall high patency (primary, assisted secondary, and secondary patency rates of 76, 88, and 92%, respectively). A statistically significant improvement in QoL scores (VEINESQOL/Sym scores) was observed in all patients as compared with the baseline at 2, 6, and 12 months after stenting (64.4, 69.2, and 73.4, respectively, $P<0.05$) along with a significant decrease in both Villalta and Venous Clinical Severity Score scores from baseline compared with 2, 6, and 12 months after the treatment (7.3, 6.4, and 6.3, respectively, $P<0.0001$ and 7.0, 6.4, and 6.2, respectively, $P<0.0001$).
Conclusions
Our results confirm the significant effect of stenting on QoL of patients with chronic symptomatic iliofemoral venous obstructive lesions with high cumulative patency rate, making it a viable treatment option.

Keywords:
nonthrombotic iliac vein lesion, obstructive, occlusions, outflow, postthrombotic syndrome, stents, venous

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Introduction

Chronic venous disease (CVD) of the legs is common around the world [1]. It causes considerable morbidity in the population, and treatment incurs significant costs to the health service. Knowledge on the epidemiology of CVD is essential to identify which patients will benefit most from treatment to slow or halt the progression of disease. CVD can result from primary or secondary causes, for example, where CVD occurs after deep vein thrombosis (DVT), and it is known as the postthrombotic syndrome (PTS), or from extrinsic iliac vein compression, and it is known as nonthrombotic iliac vein lesions (NIVLs) [1].

Patients initially seek treatment to relieve symptoms of leg pain, discomfort, heaviness, and swelling, all of which affect their quality of life (QoL). As the disease increases in severity to include varicose veins, skin changes, and venous ulcer, the demand for treatment increases while the QoL further diminishes.

During the past decade, percutaneous transluminal venoplasty and stenting have become established treatments for chronic obstruction of the iliac and caval veins in a growing number of centers worldwide [2]. Endovenous reconstruction of chronic iliocaval obstruction is one of the more challenging of all major endovascular procedures. The endovascular alleviation of the obstruction requires interventional skills with percutaneous techniques, familiarity with dedicated various venous stents, and experienced judgment in selection and placement of the venous stents.

This treatment for patients with chronic outflow lesions has been considered as an alternative to symptom reduction by conservative compression treatment if it later fails. Compared with bypass procedures, it is relatively simple, has low risk, can be performed as a day case procedure, excellent stent patency rates are reported and potentially has better symptom improvement.

Patients and methods

This study was conducted prospectively on 40 patients with chronic deep venous diseases (either NIVL or PTS) owing to presence of venous outflow lesions. All patients with chronic venous outflow lesions provided written consent for study participation. These patients presented to Vascular and Endovascular Surgery Department, Faculty of Medicine, Assiut, Egypt from July 2016 to September 2019.

This study was approved by the Medical Ethics Committee of Faculty of Medicine, Assiut University, Egypt.

In our study, we included all cases with CVI manifestations owing to presence of venous outflow obstructive lesion with clinical, etiology, anatomy, pathology (CEAP) clinical staging 3 or more, failed conservative treatment despite the use of high-graded thigh-long compression stocking, and presenting with manifestations of chronic venous occlusive diseases of more than 6 months.

We excluded patients with contrast hypersensitivity, any evidence of active malignant disease, and presence of previous deep venous surgery.

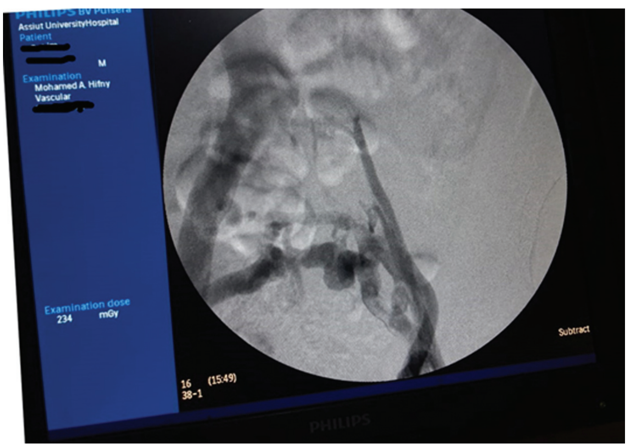
Assessment

All patients underwent full history taking, complete clinical examination, and various imaging modalities. Clinical presentation of chronic deep venous occlusive disease is widely variable, and symptoms consisting of lower extremity pain, discomfort, or heaviness and usually associated with chronic disability and diminished QoL, with major affection of patient's daily activity. Any patient having these manifestations with previous DVTs was described as having PTS. On the contrary, symptomatic patients with CVD with radiological evidence of iliac vein compression syndrome were described as having NIVL to fulfill the requirement to be included in this study. So, all patients of the study were classified into PTS and NIVL cases (Figs 1 and 2).

Investigations

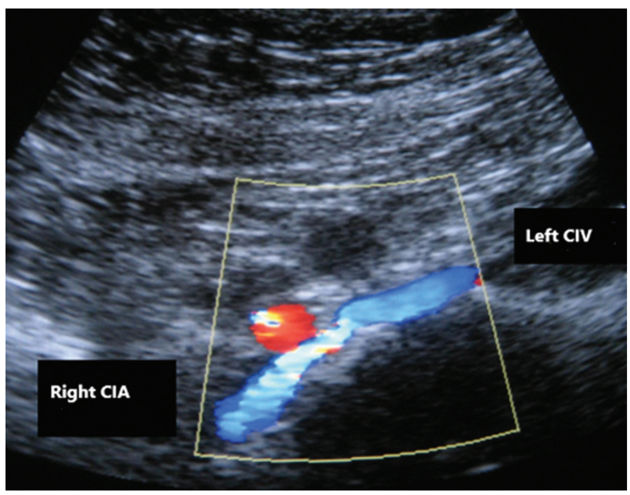
Patients underwent both laboratory (involving thrombophilia screen) and different venous imaging investigations including duplex scan, CTV, MRV, or ascending venogram to confirm the presence of

Figure 1



Conventional venography showing occluded left common and external iliac veins with pelvic venous collaterals crossing the midline draining into the contralateral side.

Figure 2



Duplex ultrasound showing compression of left iliac vein by right common iliac artery.

occluded venous segments, partial or complete recanalization, presence of external compression (NIVL), thickened vein wall, presence of residual thrombosis, and presence of pelvic collaterals. In addition, it was important to confirm or exclude concomitant superficial venous system reflux and determine the exact location of reflux.

Intervention and procedure technique

Endovascular procedures have been conducted in a hybrid suite with a wide variety of vascular interventional guide wires, catheters, snares, balloons, and stents available. All procedures have been performed under general anesthesia as the predilation of fibrotic and thickened veins can be painful, except for the case of focal localized lesion such as may thurner syndrome (MTS) or patients with multiple comorbidities, where procedures have been performed under local anesthesia and deep sedation.

Prophylactic anticoagulation was preoperatively administrated with low-molecular-weight heparin (Enoxaparin 40 mg once daily) or switching into bridging therapy, especially in PTS group of patients who were already on therapeutic anticoagulation.

In general, the access route was determined by the inflow and outflow conditions illustrated in the imaging investigations. Ultrasound-guided puncture through popliteal veins bilaterally was our normal diagnostic venography access site as a reference pre-intervention picture unless there were any occluded popliteal segments.

In certain cases, it was appropriate to combine access with a crossover or through-and-through (jugular/femoral) technique to perform recanalization. At this point, intraoperative bolus administration of unfractionated heparin (5000 IU) was usually given to all patients after access site puncture with secure sheath placement.

By using a variety of guide wires (hydrophilic and nonhydrophilic), as well as rotation and guiding catheter support, recanalization has typically been performed. Collaterals are the result of high strain rather than compensation. The initial venographic images were done using anteroposterior projection in addition to at least two or three oblique views (45, 60, and 90°). Predilation of the diseases venous segment and destruction of fibrotic trabeculae with high-pressure balloons were an important part of the procedure. Resilient stenosis/occlusions required the use of up to 30 atmospheres (i.e. high-pressure balloons).

The indications of deep venous stenting for venous outflow lesions were presence of either compression by adjacent structures (>50% vein diameter reduction) (e.g. May Thurner syndrome) or intraluminal fibrosis, which in most cases is extensive, or more than 30% residual stenosis of previous DVTs and the presence of venous collaterals.

Obstructive lesion was deemed postthrombotic (36 limbs in 26 patients) if the patient had a history of DVT diagnosed with duplex ultrasound scanning or ascending venography and was subsequently treated with anticoagulation or with venogram findings (e.g. occlusion, stenosis, and collateral vessels).

The cross-sectional area of stenosis was measured by intravascular ultrasound (IVUS) and compared with the normal vein area below stenosis, providing a percentage of stenosis. Stents have been placed in limbs shown to have more than 50% morphological stenosis by IVUS imaging. The transverse lumen region was measured by IVUS imaging during the prestent and poststent procedure.

The partly obstructed segment was balloon-dilated and stented under IVUS instructions to ensure that the entire lesion was covered. The use of large (14–20 mm) self-expanding stents with an overlap of at least 2 cm is suggested. Inflow must be secured even if it involves stenting across the inguinal ligament. At least 1–2 cm of stent is applied to the vena cava to secure the outflow and prevent confluence of stenosis. Lesions, including the proximal portion of the common iliac veins and the inferior vena cava (IVC), necessitate stenting of all three without missed area. Although there are various strategies for proper placement of dedicated venous stents, our strategy was to adopt bifurcation stents. Our strategy was to adopt bifurcation stent deployment techniques.

Stenting of a stenosis adjacent to the confluence of the common iliac veins using Wallstents required that the stent be placed well into the IVC to avoid early restenosis.

Over-sizing of the stent is usually recommended by 2 mm beyond optimal vein caliber. Postdilatation is restricted to the optimum outflow caliber for the venous segment.

Postoperative management

Standard postoperative ward care of patients after stent procedure included frequent access site check, start mobilization 4 h after the procedure, and commencing low molecular weight heparin (LMWH) 4 h after successful procedure. Patients were discharged from vascular ward on next day morning after confirmatory duplex scan done by a vascular expert, ensuring widely opened and patent venous stent.

Postoperative anticoagulation regimen

Anticoagulation therapy after deep venous stenting was administrated to all patients in the form of bridging therapy with LMWH for 10 days together with oral anticoagulation (warfarin is preferred) as well as of dual antiplatelet therapy. Oral anticoagulant was continued till at least for 1-year while patients were kept on single antiplatelet after 6 months follow-up for long-life.

Follow-up and outcome assessment

Each patient was scheduled for regular follow-up visits to the outpatient clinic by clinical examination and duplex scanning at 2, 6 weeks, 3, 6, and 12 months. In addition, postprocedure Villalta and VEINISQOL/Sym were recorded at each clinic visit.

All patients were advised to contact the hospital urgently in the event of developing any leg swelling or pain.

Reintervention

During routine follow-up visits, reintervention is only indicated if more than 50% in-stent narrowing has been diagnosed in symptomatizing patients by balloon venoplasty or in context of acute stent thrombosis by pharmacochemical thrombolysis (PMT) using Cleaner XT (rotational thrombectomy system; Argon Medical Devices, Frisco, TX, USA).

Concurrent procedures

For some patients with mixed superficial reflux and obstructive pathologies, deep venous stenting was paired with procedures for managing superficial venous reflux (great saphenous vein or small saphenous vein ablation using 'VNUS Closure FAST, Covidien, Dublin, Ireland' +/−stab avulsions) in a separate session before stenting.

Statistical analysis

Data were collected in a prospective manner, and the results were tabulated using Microsoft Excel (Version 1702; Redmond, Washington, USA). Descriptive statistics were used with continuous variables expressed as mean±SD, and categorical variables as frequency and percentage. The statistical analysis was performed with SPSS 20.0 software (IBM, USA). The Kaplan–Meier survival analysis was conducted to present actual survival curves to compare primary and secondary patency levels, as well as effectiveness and competency. Paired t test was used to assess the importance of the clinical outcomes.

Results

Patient numbers and characteristics

A total of 40 patients (50 legs) were treated. Mean age was 45.2 years (range, 18–75 years), and 21 (52.5%) patients were males. According to CEAP clinical score, 31 (62%) limbs were class 3, whereas limbs with C4–6 constituted 38% of the study group. Approximately three of the patients had hyperpigmentation of the lower limbs, dermatitis, lipodermatosclerosis, healed venous ulcers, or active ulcers. The etiology was primary (NIVL) in 14 (35%) limbs and secondary (postthrombotic) in 36 (65%) limbs. Deep venous outflow obstruction with no reflux was observed in 30 limbs and combined reflux/obstruction in 20% of limbs. Among the 10 limbs with reflux and obstruction, reflux was observed among four (8%) in the deep system alone, four (8%) in the superficial system alone, and none of the limbs in the combined systems. On the contrary, NIVL was commonly caused by MTS in almost 92% of NIVL group of patients and rarely by other pathologies owing to retroperitoneal fibrosis in only remaining patient. The iliac vein was the most involved venous segment in almost 44% of the treated patients, followed by unilateral and bilateral iliofemoral segments in 14% of cases each (Tables 1–3).

Thrombophilia testing was performed in 17 (42%) patients. A total of six (14%) patients had well-documented hypercoagulability (either previously discovered during initial admission or diagnosed during follow up periods), whereas it was negative in 28% of patients. However, it was unknown in 23 patients (Fig. 3).

Table 1 Patient demographics

Patient characteristics	*n* (%)
Total number of patients	40
Total number of involved limbs	50
Age [mean±SD (range)] (years)	45.2±12 (18–75)
Male	21 (52.5)
Right sided	4 (10)
Left sided	26 (52.5)
Bilateral	10 (25)
Thrombophilia	6 (15)
History of pulmonary embolism	2 (5)
PTS patient group	26 (65)
NIVL patient group	14 (35)
Average follow-up by months (range)	16.9 (13.1–35.5)

NIVL, nonthrombotic iliac vein lesion; PTS, postthrombotic syndrome.

Table 2 CEAP etiology and clinical scoring

CEAP	PTS group	NIVL group	Number of limbs (%)
C3	18	13	31 (62)
C4a	3	1	4 (8)
C4b	6	0	6 (12)
C5	7	0	7 (14)
C6	2	0	2 (4)
Total	36	14	50 (100)

CEAP, clinical, etiology, anatomy, pathology;NIVL, nonthrombotic iliac vein lesion; PTS, postthrombotic syndrome.

All patients were assessed by duplex scan to determine presence of concomitant either superficial or deep venous reflux, as described in Table 4.

Technical success and other surgical results

Recanalization and placement of stents were successful and effective in all 50 limbs. Endovenous procedures were conducted under general anesthesia in 22 patients and sedation plus local anesthesia in the remaining 18 patients. Patients under local anesthesia with deep sedation encountered back pain during predilation and stent placement; however, the treatment was well accepted by all patients.

Unilateral common femoral vein (CFV) access was used in 30% (12/40), bilateral CFV access was used in 10% (4/40), unilateral popliteal vein access was used in 18.2% (6/40), bilateral popliteal vein access was used in 22.5% (9/40), unilateral mid-thigh femoral vein access in 5% (2/40), bilateral mid-thigh femoral vein access in 7.5% (3/40), and right internal jugular access together with bilateral popliteal vein access in 10% (4/40).

A total of 24 limbs had stents extending into the typical femoral vein (23 limbs had stents extending into the CFV itself and one of them had stents extending into the deep femoral vein). A total of 95 stents were deployed in all 50 limbs: 81 stents in 36 limbs with PTS, whereas 14 stents in 14 limbs with NIVL. The maximum number of stents per patient was eight in PTS group, and only one in each limb in NIVL group of patients [VICI VENOUS stents (Boston Scientific, USA) 87, Optimed Sinus XL 8].

Lesion outcomes

Intraoperative assessment of lesion characteristics using multiplanar venography together with IVUS is illustrated in Table 5.

In addition, infrarenal IVC filters were detected during intraoperative conventional venography in three patients with PTS owing to previous trial of thrombolysis following extensive iliofemoral DVTs. However, none of these filters were the main etiology of obstructive outflow lesions.

Table 3 The distribution of involved venous segments

Involved segments	*n* (%)
Iliac venous segment	
Unilateral	22 (44)
Bilateral	1 (2)
Iliocaval segment	
Unilateral	0
Bilateral	1 (2)
Ilio-femoro-caval segments	
Unilateral	7 (14)
Bilateral	7 (14)
Entire venous segments (Ilio-femoro-popliteal segments)	
Unilateral	1 (2)
Bilateral	1 (2)
Total limbs 50	

Stent patency

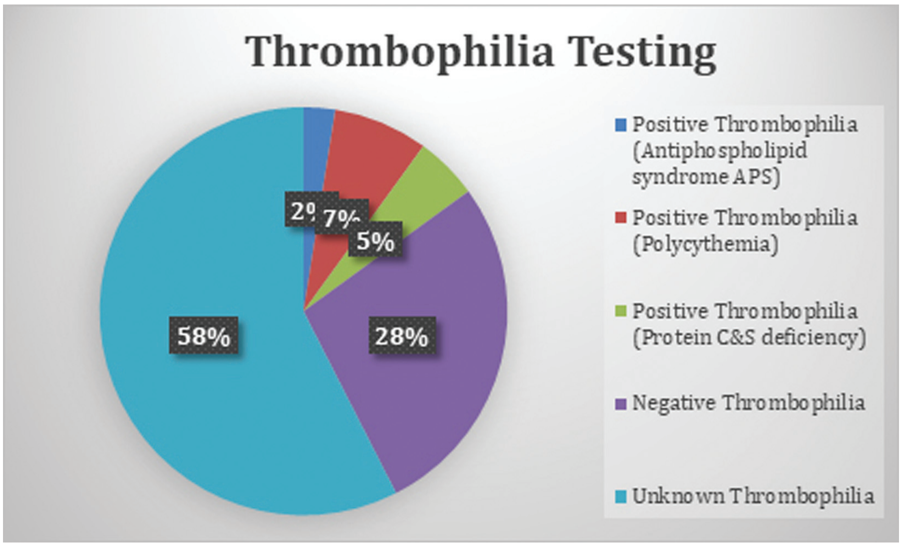
Venogram or iliofemoral venous duplex imaging have been performed in all 50 limbs to identify the patency of deep venous stents during an average period of 30 months following initial stent placement. Cumulative patency rates are summarized in Table 6.

The average primary, assisted primary, and secondary combined patency rates at 12 months were 76, 88, and 92%, respectively (Figs 4–6). Under the follow-up period, two secondary procedures were performed 1–11 months after initial stenting to preserve the disease (in-stent restenosis >50%) along with the presence of untreated or recurring symptoms. Further venoplasty was performed for a stenosis detected below the initial stent in one limb, and venoplasty of in-stent restenosis of deep venous stents was performed in five limbs.

Early thrombosis of the stented iliac vein did not occur in any limb or in the contralateral iliac vein, at the femoral access or in the calf venous plexuses. All four cases of in-stent narrowing occurred in postthrombotic limbs. They had adjunctive venoplasty procedure in the form of ballooning without stent placement owing to presence of 30% in-stent stenosis apart from one case where combined procedure was performed.

Late stent occlusion occurred in six (12%) limbs and was successfully lysed in two; thus, stents in two limbs remained occluded, as one patient had recurrent active metastasis and the remaining patient refused stenting and accepted Palma procedure. The remaining two cases were unsuccessfully lysed at 5.5- and 6-month follow-up owing to the presence of nonocclusive distal thrombosis. Furthermore, there were two cases of distal

Figure 3



Thrombophilia screening results among patients of this study.

Table 4 Venous duplex ultrasound findings in all patients

Reflux	
Superficial SFJ reflux	4 limbs
Superficial SPJ reflux	0
Perforators incompetence	2 limbs
Deep venous system reflux	4 limbs

Table 5 Characteristics of venous lesions detected by different imaging modalities

Lesion characteristics	Total interventions per limb: 50 [*n* (%)]
50–70% stenosis	17 (34)
>70% stenosis	29 (58)
Total occlusion	4 (8)

Table 6 The cumulative primary, assisted primary, and secondary patency rates

	0 days	3 months	6 months	9 months	12 months
Primary patency	50	45	40	38	38
Assisted primary patency	50	48	45	43	44
Secondary patency	50	49	46	45	46

vein thrombosis with remain patent proximal iliac stent.

During follow-up, six patients had adjunctive venoplasty: one had two adjunctive procedure with additional stent placement below the intimal stent deployed, whereas others had successful venoplasties owing to in-stent stenosis more than 50% without any intraoperative complications. However, there was one patient who had adjunctive venoplasty during follow up at one month, become occluded at 5.5 months after unsuccessful lysis attempt.

Poststenting complications

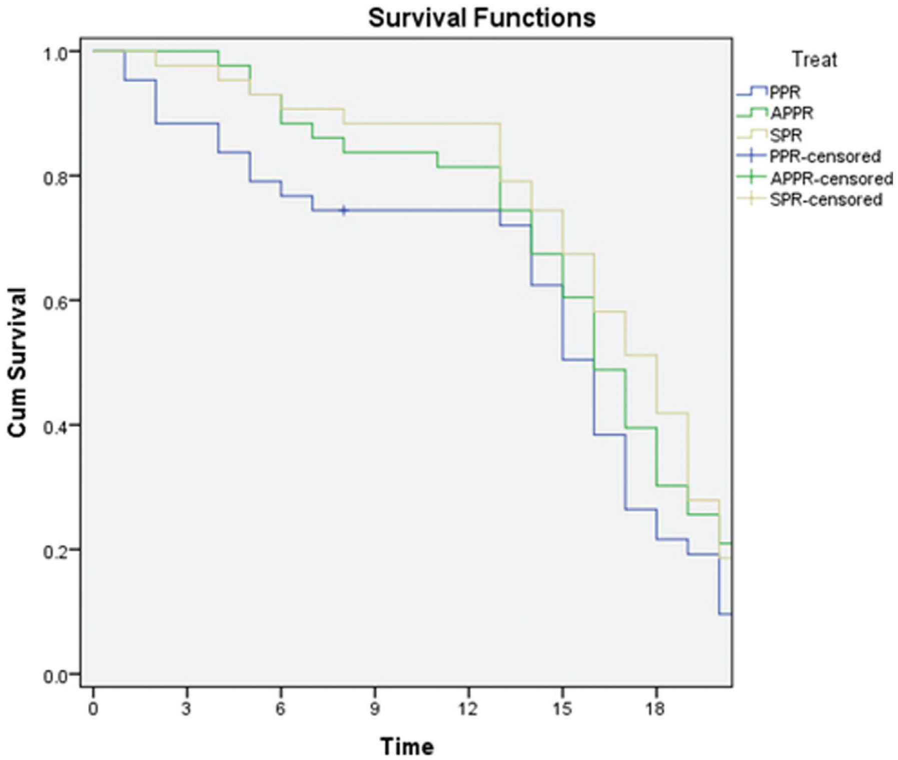
Among 40 cases, five access-related complications occurred (12.5%) (two scrotal bleeding and three popliteal fossa bleeding). All these cases were managed conservatively and did not require blood transfusion or vessel repair. This may be attributed to ultrasound-guided access in these limbs together with gradual upgrading of the sheath sizes during the procedure. No serious procedure-related complications were reported such as pulmonary embolism or stent migration and embolization. However, three (7.5%) patients experienced vasovagal syncope during already painful stent procedure, and they were managed consequently. In addition, low back pain was experienced in five (12.5%) patients during early postoperative period (< 30 days), which was relieved by pain killers.

Late postoperative complications (>30 days) were reported in eight (16%) limbs where occlusion of the stented iliofemoral venous segments occurred in six limbs during follow-up periods. The remaining two case reported distal vein thrombosis with widely patent proximal iliac venous stent. There were no reported cases of stent fracture or migration especially those deployed across the inguinal ligaments. There was no mortality (30 days) in stenting procedures.

Clinical and quality-of-life scores at follow-up

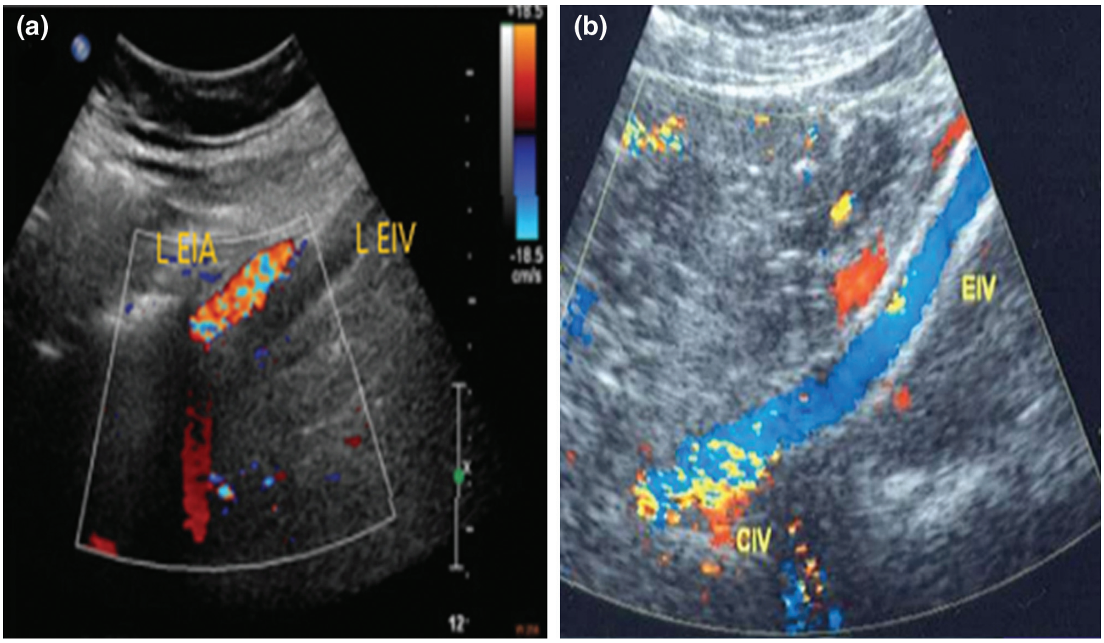
The mean Venous Clinical Severity Score (VCSS) decreased from 9 at baseline to 7 at 2 months and six

Figure 4



Kaplan–Meier curve shows the primary, assisted-primary, and secondary patency rates for vein segments treated by endovascular intervention, calculated per leg at 12-month follow-up. PPR, primary patency rate; APPR, assisted primary patency rate; SPR, secondary patency rate.

Figure 5

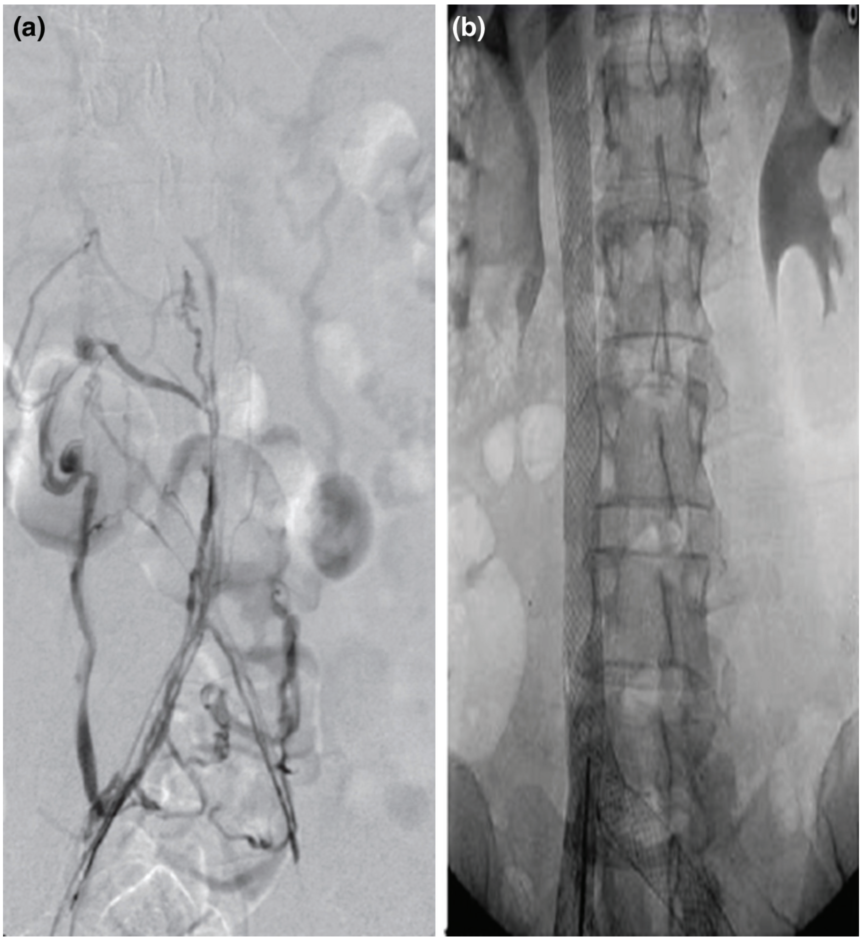


(a) Duplex scan of case of occluded left external iliac vein and (b) follow-up image showed widely patent left iliac venous stent at 2 weeks of follow-up visit.

at both 6- and 12-month follow-up (P<0.001). Mean Villalta score decreased from 10 at baseline to 7 at 2 months and 6 at 6 and 12 months (P<0.000).

Furthermore, the mean VEINS QoL scale increased from 54 at baseline to 64 at 2-month follow-up and to 69 at 6 months and to 73 at 12-month follow-up (P<0.001) (Table 7).

Figure 6



Patient with iliocaval venous stenting owing to chronic total occlusion resulting from extensive postthrombotic lesions involving both caval and iliac veins: (a) chronic total occlusion and (b) postoperative iliocaval stents.

Table 7 Paired *t* test for Venous Clinical Severity Score, VEINESQOL/Sym, and Villalta scores for patients preoperatively and postoperatively indicating response to treatment

	Baseline	2 months	6 months	12 months	*P* value to 12 months
VCSS	9.2±3.8	7.0±3.3	6.4±3.2	6.2±3.3	0.001
VEINESQOL/Sym scores	54.8±11.5	64.4±15.5	69.2±14.6	73.4±16.2	0.001
Villalta scores	10.4±4.6	7.3±4.3	6.4±3.8	6.3±4.4	0.001

VCSS, Venous Clinical Severity Score.

Based on the categorical Villalta scale (no, mild, moderate, or severe PTS) in the 49 limbs (39 patients) who completed 1-year follow-up, 40 limbs improved on this scale, six were unchanged, and three became worse. Two patients (with two limbs) had ulcers that healed 42 days after the intervention, without recurrence.

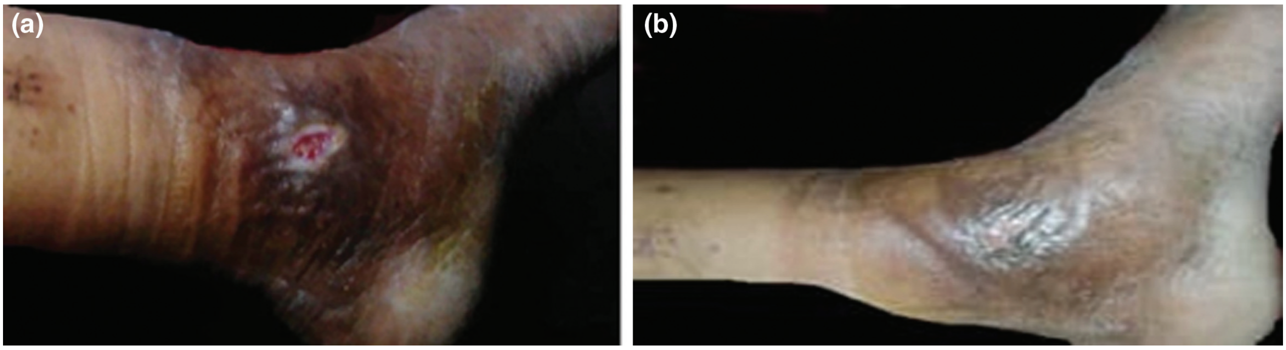
Ulcer healing outcome

Healing of leg ulcers was followed up in two limbs (C6) of PTS group of patients with complete healing at 6 weeks after stent placement. However, these two patients had neither SFJ nor SPJ reflux which had been excluded by duplex venous scan before intervention (Fig. 7).

Reintervention

Reintervention was conducted in three patients with acute signs of stent occlusion (within 2 weeks of presentation). Once diagnosed, the patients were shifted to LMWH, preparing them for PMT using Cleaner XT (rotational thrombectomy system; Argon Medical Device). PMT was successful in all three cases; however, one of them developed rethrombosis at 5 months of follow-up owing to patient noncompliance on antithrombotic regimen. A trial of thrombolysis was unsuccessful in this patient. Moreover, PMT was unsuccessful in another case at 5 months owing to presence of nonocclusive distal thrombosis with extensive venous webs and synechiae.

Figure 7



Venous ulcers: (a) active and (b) healed within 6 weeks after initial procedure.

The remaining third patient had unsuccessful trial of thrombolysis at 5 months after initial stent placement owing to patient noncompliance on conventional antithrombotic regimen and presence of thrombosis distal to the stented venous segment.

Additionally, two patients with stent occlusion occurred at 5 and 5.5 months correspondingly, and they did not undergo reintervention owing to presence of metastases to vital organs or patient refusal.

Discussion

Stenting of deep venous outflow obstruction of the lower extremities can be done at low risk, with a long-term high patency rate, and with a low in-stent restenosis rate [2]. This resulted in considerable symptom relief in patients with CVD, which was not reliably expressed in any substantial hemodynamic change by conservative measurements [3]. Although there are numerous small case reports in the literature, only a few larger series of suitable short-term to mid-term follow-ups have been reported. Most of these cases combine limbs stented for recurrent obstruction with those stented after clot removal. However, this study reported satisfactory full-term patency results, emphasizing the growing concept for considering venous stenting is the first and optimal management option in patients with venous outflow lesions [2].

In an important systematic review reported by Seager *et al.* [1] on deep endovenous stenting to relieve CVD secondary to postthrombotic or nonthrombotic iliac vein obstruction, the primary and secondary stent patency ranged from 32 to 98.7% and 66–96%, respectively. The major complication rate ranged from 0 to 8.7% per stented limb. In addition, there were significant improvements in validated measures of the severity of CVD and venous disease-specific QoL.

In another major meta-analysis, summarizing the efficacy and safety of venous stents in chronic obstructive venous, the primary, assisted primary, and secondary patency rates were 91.4, 95.0, and 97.8%, respectively, at 12 months and 77.1, 92.3, and 94.3%, respectively, at 36 months. Patency rates in the PTS were lower than in the NIVL. In addition, 30-day thrombotic incidents were 2.0% (4.0% in PTS vs. 0.8% in NIVL, P=0.0002). In comparison, with stent placement, there was substantial pain and edema relief in these patients, and the CEAP scores declined. The ulcer healing rate was 72.1% (70.3% in PTS vs. 86.9% in NIVL, P=0.0022), and the ulcer recurrence rate was 8.7% [4].

In a randomized clinical trial performed by Rossi *et al.* [5], iliac vein stenting was 100% technically successful. At 6-month follow-up, the mean VAS pain score declined from a median of 8 to 2.5 in patients receiving stents and from 8 to 7 in patients receiving only medical treatment (P<0.001). The Venous Clinical Severity Score decreased from a median of 18.5 to 11 after stenting and from 15 to 14 with medical treatment (P<0.001). The 36-Item Short Form Health Survey (0–100) improved from a total median score of 53.9 to 85.0 with stenting and 48.3 to 59.8 after medical treatment (P<0.001). There was no stent fracture or migration, and the primary, assisted primary, and secondary patency rates were 92, 96, and 100%, respectively. Our study supports these findings.

It is well known that inherited and acquired thrombophilia increase the risk of venous thromboembolism, and in particular, the antiphospholipid syndrome, which is an acquired thrombophilia, and is associated with an increased risk of recurrent venous thromboembolism. In the current study, we reported occluded iliac stent in one limb during follow-up period owing to acquired thrombophilia secondary to active metastases, whereas the rest of previously diagnosed inherited thrombophilic patients did not show any stent blockage. That is why iliofemoral venous stenting in patients with thrombophilia is still controversial.

In our study, stent occlusion was reported in four (8%) PTS limbs after failed lysis or without any reintervention. This result coincides with in-stent occlusion rate reported in stent placed for postthrombotic etiology (~77%) in a study by Jayaraj *et al.* [6]. In contrast, occlusion in stented patients with NIVLs is rare.

Deep venous stenting is increasingly used in the treatment of deep venous obstruction; however, there is currently no consensus regarding postprocedural antithrombotic therapy. The duration and type of anticoagulation after chronic recanalization procedures is not well studied [7]. As a general rule, thrombotic venous disease needs to be medically managed more aggressively after a procedure than nonthrombotic disease owing to higher rethrombosis rates in the former group [8].

A typical regimen will include an enoxaparin bridge to warfarin. More practitioners are considering rivaroxaban as a warfarin alternative; however, data are lacking regarding its efficacy after recanalization and in the setting of stent procedures. In addition, the compliance and adherence of patients to oral anticoagulants are crucial during postoperative care to avoid significant oral anticoagulant-free periods [9,10]. In a study conducted by Keita *et al.* [10], it recommended long-term therapy (for at least 12 months) for postthrombotic lesions, whereas nonthrombotic disease is typically managed with 1–3 months of anticoagulation. Antiplatelet agents such as aspirin and clopidogrel are used by many after venous stent placement, but this practice is based on arterial data and physiology [11].

In this study, we reported four cases with combined superficial SFJ reflux and venous outflow lesions. These patients were treated with radiofrequency ablation in separate setting procedure before endovenous stenting reconstruction. Another one case with incompetent perforators was treated with successful injection sclerotherapy under duplex guidance. This strategy coincides with that reported by Neglen *et al.* [13], where saphenous ablation can be performed before iliac vein stenting if superficial reflux is determined.

In this study, multiplanar venography rather than single plane was used as a gold standard image modality to identify presence or absence of outflow lesions. In addition, IVUS was used during intraoperative assessment of lesions and during stent deployment initially or in case of any suspected in-stent lesions that may necessitate re-intervention. This policy coincides with a study performed by Raju *et al.* [12], in which in comparison with IVUS, venography substantially and significantly missed stenotic lesions and their location and severity.

Stenting across the inguinal ligament is still a controversial topic. Unlike stenting within arterial system, there is a concern of similar events could happen when stents are placed in the same position within the venous system. It is observed that several studies [14–16] reported worse stent-related outcomes that occurred when the venous stenting is carried underneath the inguinal ligament into the common femoral vein. In contrast, Neglén *et al.* [17] reported that it is safe to extend stents across the inguinal ligament when the obstructive lesion involves CFV. In a study reported by Black *et al.* [18], no significant differences were found in clinical and stent outcomes in patients with stenting terminating above or below the inguinal ligament, suggesting that stenting across the inguinal ligament is not a significant factor in patency and clinical outcomes.

In our study, we support the use of venous stenting across the inguinal ligament in case of diseased CFV. Moreover, the infra-inguinal inflow assessment is fundamental during endovenous stent procedure, especially in case of iliofemoral postthrombotic obstructions. In general, the optimal endovenous stent placement is from one healthy vein segment to the next, obtaining adequate inflow and outflow [19,20]. In severe postthrombotic obstructions involving infra-inguinal veins, optimum stent positioning with respect to inflow is frequently questioned. In ~10–15% of patients with chronic venous femoropoliteal obstruction, deep femoral vein caliber and flow may increase over time, and this turns the deep femoral vein into a major outflow collateral. The movement of the deep femoral vein is called axial transformation.

After axial transformation, the deep femoral vein can serve as an alternate inflow route for stenting and a possible stent landing zone. In a retrospective review conducted by Grøtta *et al* [19], it was concluded that infra-inguinal endovenous stent placement was feasible and safe for good-patency care (78% at 24 months) and better clinical outcomes (72%). Patients with severe signs of postthrombotic obstructions and infra-inguinal involvement should be treated. In addition, patients with 'healthy' inflow were more attentive compared with those with 'fair/poor' (P=0.01), and the inflow seemed to be the most significant predictor of the disease than the position of the lower stent line. In our study, we considered this concept during deep venous stenting process where venous stent was extended into PFV in one limb as PFV had good inflow and was not performed in another limb after unsuccessful attempt of thrombolysis owing to presence of nonocclusive distal thrombosis with extensive webs and spurs to allow building up good collaterals for future stent consideration with better inflow.

The indications for reintervention in malfunctioning iliac stents are emerging with the rapidly increasing evidence base but should be viewed as relatively simple like patients returning to vascular clinic with recurrent symptoms, occlusion/malfunction identified on routine surveillance, and venous in-stent stenosis of more than 50% diameter reduction on symptomatic patients [18,21]. In a study performed by Gustafson *et al.* [22] to develop an intravascular ultrasound-based scoring system to help to predict future venous stent failure, it was concluded that a seven-category IVUS-based scoring system may have a role in predicting it, as higher composite scores were associated with increased stent failure, as well as an increased relative risk of it occurring. However, this scoring system needs further validation either in the form of retrospective or prospective examination, potentially by expanding into other institutions [22].In our study, adjunctive arteriovenous fistulae (common femoral artery and vein) were not required in any of our cases. However, it is planned to be used in case of recurrent intraoperative in-stent thrombosis. In general, concomitant arteriovenous fistulae may be used as a temporary adjunct to increase flow and maintain patency through stented segments. However, the results are not sufficiently superior to recommend their routine use [23]. Thus, arteriovenous fistulae may be used selectively in those with poor inflow or in the context of endophlebectomy [23,24].

Although there are studies on the value of endovenous stenting, there has been a shortage of controlled trials. A randomized trial comparing venous stent with conservative care is underway, and its testing protocol has been published [24].

There were some limitations in this study including its prospective and nonrandomized nature, in addition to the small number of patients included in this study.

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Conflicts of interest

There are no conflicts of interest.

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