Endovascular Deep Vein Stenting of Symptomatic Post-Thrombotic and Non-Thrombotic Iliac Vein Stenotic Lesions: A Multicentre Cohort Experience from Singapore

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Abstract

Introduction: This paper presents our experience with deep venous stenting in a multi-ethnic Asian cohort of patients with symptomatic Non-Thrombotic Iliac Vein Lesions (NIVL) and Post-Thrombotic Syndrome (PTS). Materials and Methods: This was a multicentre retrospective cohort study of patients who had symptomatic deep venous disease. Stent patency rate was evaluated using Duplex ultrasonography immediately post-intervention and at 3, 6 and 12 months. Clinical outcomes were evaluated using the revised Venous Clinical Severity Score (rVCSS) and Visual Analogue Scale (VAS) pain score at baseline and 3 months post-procedure. Results: 87 patients (males = 47/87 (54.0%)); median age = 62 years (IQR 55 – 70)) and 115 limbs were analysed (left = 76/115 (66.1%)). Median follow-up time was 175 (IQR 57 – 257) days. 97/115 (84.3%) had NIVLs and 55/115 (47.8%) had May-Thurner-Syndrome. 43/115 (37.4%) had Clinical, Etiology, Anatomy and Pathophysiology (CEAP) 6 disease. Primary stent patency rates were 98.2% (112/114), 97.9% (93/95), 95.7% (89/93) and 92.8% (64/69) immediately post-intervention, 3, 6 and 12 months, respectively. The 6-month secondary patency rate was 99.1% (114/115). Mean rVCSS and VAS improved from 11.52 (±3.54) to 5.77 (±2.36) (P < 0.01) and 6.62 (±1.93) to 2.92 (±1.50) (P < 0.01) respectively, at 3 months. 41/43 (95.3%) venous ulcers healed over a median time of 169 days (IQR 120 – 253). Conclusions: Short term primary patency rates following deep venous stenting are excellent, with few re-interventions. Patients presented with NIVLs rather than PTS. There was excellent clinical improvement at 3 months, with a high and expedient venous ulcer healing rate.

Key words: Deep vein stenting, May-Thurner Syndrome, Non-thrombotic iliac vein lesion, Post-thrombotic syndrome, Vascular patency

Introduction

Chronic ilio-femoral venous obstruction (IFVO) is a debilitating disease. Symptoms include venous claudication, swelling and venous stasis ulcers. Non-thrombotic iliac vein lesions (NIVL) and post-thrombotic syndrome (PTS) can cause IFVO. NIVL includes May-Thurner Syndrome (MTS), where the left common iliac vein (CIV) is compressed between the right common iliac artery and the 5th lumbar vertebra. Right sided and bilateral MTS have also been reported, albeit rare. PTS develops in up to half of patients with deep vein thrombosis (DVT), causing intraluminal scarring and venous obstruction. Previously, IFVO was treated with analgesia, compression stockings and anticoagulation. Bypass surgery was done for severe cases but results were guarded and is not considered to be first line treatment. Recently, percutaneous deep vein stenting has been shown to be an effective treatment modality for such lesions, regardless of aetiology. Dedicated venous stents...
with high radial forces and flexibility are now used.7
Multiple studies have reported high technical success
rates and positive clinical results. A meta-analysis
conducted by Wang et al showed that endovascular
stenting of IFVO was associated with low complication
rates and desirable long-term patency rates.9 While
existing studies show favourable clinical outcomes, most
capture a vastly Caucasian demographic.7,10,11 There are
few reported studies investigating the efficacy of deep
vein stenting with intravascular ultrasound (IVUS)
technique, and the epidemiology of IFVO in a multi-
ethnic Asian background, such as that in Singapore.12
Most existing Asian studies investigated patients with
computed tomographic venogram (CTV) or venography,
without IVUS. The majority of these studies used
venography to diagnose IFVO and place their stents, which
also were not dedicated to the venous system.13–19 We have
previously reported that truncal vein diameter, distribution
of venous reflux, and symptomatology may differ
between Asians and Caucasians.20

The deep vein stenting experience in Singapore is
relatively immature with only a few centres performing
this potentially quality of life (QoL)-changing procedure.
To date, no local outcome data has been published.
Singapore General Hospital (SGH) set up its deep venous
program in April 2018, and has performed over 160 such
procedures since.

The aim of this paper is to present our experience
with deep venous stenting of IFVO, for symptomatic
NIVL and PTS patients. Short-term clinical outcomes
and stent patency rates of patients from a multi-ethnic
Asian background in Singapore were evaluated.

Materials and Methods
Patients and Study Design

This was a multi-centre retrospective review of 87
patients (115 legs; 118 interventions) with symptomatic
PTS or NIVL deep venous lesions, who underwent
endovascular ilio-femoral stenting with IVUS from
May 2014 to May 2019 (5 years) at 3 of our local public
hospitals, under the care of the senior author (TYT)
as the primary physician. The majority of patients had
at least 6 months of follow-up. The indications for
depth vein intervention were symptomatic patients with
severe chronic venous insufficiency affecting their
QoL. They were offered IVUS and stenting after
secondary causes (cardiac, renal, hepatic) of lower
limb oedema were excluded. Patients with CEAP
classification21 4a disease status and above were
included. Patients’ case notes and electronic records
were reviewed. Patient demographics, co-morbidities,
pre-morbid functional status, CEAP classification, along
with procedural, angiographic and follow-up data were
retrieved. The severity of chronic venous insufficiency
and pain score were evaluated by the rVCSS22 and a
numerical VAS, respectively, pre- and post-intervention
(3 months). The local Institutional Review Board
approved this study (CIRB no. 2018/3150).

Pre-operatively, all patients had a contrast-enhanced
CTV or magnetic resonance venogram (MRV) to not only
look for iliac vein compression, but (more importantly)
also rule out intra-abdominal masses that may cause
extrinsic venous compression. Pre-operative Duplex
ultrasonography (DUS) was performed to investigate
the presence of concomitant superficial and deep venous
reflux. Follow-up of stent patency was performed using
DUS and was standardised at Day 1 post-op and at 3,
6 and 12 months after intervention. Clinical outcomes
were evaluated by comparing the rVCSS and VAS pain
score at baseline and at 3 months after intervention.
Healing times of venous ulcers were also documented.
All venous ulcers had 4-layer compression applied until
their wounds healed.

Procedure and Postoperative Care

The procedure was performed with the patient under
general anaesthesia or deep sedation in the supine
position. The ipsilateral femoral vein was accessed in an
antegrade fashion, under ultrasound guidance, typically
in the mid-thigh region using an 18-gauge needle with an
aspiration 5 ml syringe. A 5 French (Fr) vascular access
sheath (GLIDESHEATHTM, Terumo Medical, Tokyo,
Japan) was inserted and digital subtraction venograms
were performed to image from the femoral vein up to the
distal inferior vena cava (IVC) in at least 2 orthogonal
planes. The venograms helped to identify stenosis or
occlusion of the iliac veins and the presence of any
collateral draining veins, which may indicate a significant
stenosis. The ilio-femoral segment was crossed using a
combination of a 4F Bernstein catheter (TempoTM,
Cordis, USA) and a 0.35″ hydrophilic angled guidewire
(Glide wireTM, Terumo Medical, Tokyo, Japan) under
fluoroscopy. The hydrophilic guidewire was exchanged
for a 0.35″ stiff guide wire (HI-TORQUE SupracoreTM
Abbott Medical, USA) wire and the access sheath was
upsized to a 10 Fr (GLIDESHEATHTM, Terumo Medical,
Tokyo, Japan) to allow IVUS interrogation and stenting,
if required. The IVUS catheter (VolcanoTM, Philips
Healthcare, Eindhoven, Netherlands) was introduced
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over the guidewire into the distal IVC under fluoroscopy guidance and a preliminary pullback scanning run was performed to get an overview of the ilio-femoral lesions. IVUS pullback was performed both over the guidewire and without it, as the senior author had come to appreciate, with experience, that one can potentially get vessel distortion using the stiff wire, making a potential venous stenotic lesion more pronounced than it actually is. The lesions were typically eccentric rather than concentric and hence, cross sectional areas of the distal IVC, proximal CIV, mid CIV, iliac confluence, proximal mid and distal external iliac vein (EIV) and common femoral vein (CFV) were measured using the IVUS. In our experience, IVUS provides the most accurate estimate of the severity and extent of the venous lesions as well as the diameters of the normal iliac veins, which are not appreciated by venography alone, and is essential for deep venous intervention procedures. During the procedure, full anticoagulation with unfractionated heparin was given, targeting an activated clotting time of around 250 to 300 seconds. Pre-dilatation was performed using an appropriately sized balloon (usually 16/18 x 40/60 mm Atlas balloon, BD Medical, USA) for CIV and 14 mm x 40/60 mm balloon for EIV/CFV). Using combined IVUS and fluoroscopic guidance, stents were deployed across the affected segment with a premise of stenting from normal to normal venous zone with no spot stenting allowed. Most of these lesions were chronic in nature and venoplasty alone was not sufficient to treat the fibrotic lesions. We preferred using dedicated self-expanding venous stents (Venovo™, BD Medical, USA; Sinus Venous™, Sinus Obliquus™ Optimed, Germany). In our practice, we prefer to use the oblique venous 16 mm diameter stents (Sinus Obliquus™, Optimed, Germany) for proximal CIV/MTS lesions as it provides the advantage of adequate coverage of the lesion without the risk of covering the contralateral CIV origin. We performed routine post dilatation of the stents with the appropriate sized balloons to achieve complete expansion of the stents. Venograms and IVUS were performed post-stent deployment to confirm adequacy of treatment, blood flow and for potential complications. The cross-sectional areas of the various segments of the veins were recorded and documented pre- and post-stenting. The access sheath and wires were removed and haemostasis was achieved with manual compression for 10 minutes without requiring any compression dressing or closure device.

Patients were placed in intermittent pneumatic compression postoperatively (Flowpac; Huntleigh Healthcare, Cardiff, UK) to promote flow through the stented segments of the vein. Therapeutic low-molecular-weight heparin (enoxaparin) was administered the same evening, followed by conversion to either warfarin (target international normalized ratio 2.0–2.5) or new oral anticoagulants (rivaroxaban 20 mg/d). For NIVL patients, anticoagulation was switched to aspirin (100 mg/d) or clopidogrel (75 mg/d) if DUS was satisfactory at 6 months. Those with PTS were either left long-term on NOAC/warfarin or switched to an antiplatelet agent after 1 year, depending on their thrombophilia status.

Outcome Definitions

Technical success was defined as successful deployment of stents to their intended locations. Procedural success was defined as technical success with at least one indicator of hemodynamic or clinical success. Stents were defined as patent when the DUS showed antegrade flow and a spontaneous Doppler signal, with maximal luminal stenosis of ≤50%. Primary patency rate was defined as the percentage of patients with uninterrupted stent patency until reintervention was required or in-stent thrombosis occurs. Secondary patency rate was defined as the percentage of patients with stent patency after primary procedural and technical success, irrespective of interval therapies.

Statistical Analysis

Continuous numeric variables were reported as mean and standard deviations for parametric distribution, and median (interquartile range (IQR)) for non-parametric distribution. Categorical variables were reported as absolute numbers and percentages, unless stated otherwise. Continuous numeric data were compared using the Student t test or Mann–Whitney U test for parametric and non-parametric data, respectively. Categorical data were compared using the Chi-square or Fisher’s Exact tests.

Statistical significance was assumed at P < 0.05. Kaplan-Meier survival estimation was used to calculate stent patency rates. The statistical analyses were performed using SPSS statistical software version 25.0 (IBM Corp, Armonk, NY, USA).

Results

Baseline Demographics

87 patients with a median age of 63 (IQR 55–70) years were included. A total of 115 limbs were involved. As of June 2019, median follow-up time was 175 (IQR 57–257) days. Table 1 shows the baseline demographics. Forty-seven (54.0%) were male, and 25 (28.7%) patients had bilateral disease. All the patients were symptomatic with 43 (37.4% of 115) limbs having
Deep Vein Stenting: Singapore Experience—Mervin Nathan Lim Han Hui et al

Table 1: Baseline Demographics

<table>
<thead>
<tr>
<th>Variable</th>
<th>N = 87 patients (%) (IQR) (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>62 (43–82)</td>
</tr>
<tr>
<td>Male</td>
<td>47 (54.0%)</td>
</tr>
<tr>
<td>Duration of symptoms, months</td>
<td>12 (1–360)</td>
</tr>
<tr>
<td>Bilateral venous disease</td>
<td>25 (28.7%)</td>
</tr>
<tr>
<td>BMI</td>
<td>28.50 (SD ± 6.31)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>32 (36.8%)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>66 (75.9%)</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>65 (74.7%)</td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>17 (19.5%)</td>
</tr>
<tr>
<td>Obstructive sleep apnea</td>
<td>11 (12.6%)</td>
</tr>
<tr>
<td>Coagulation disorder</td>
<td>7 (8.0%)</td>
</tr>
<tr>
<td>Previous DVT</td>
<td>16 (18.4%)</td>
</tr>
<tr>
<td>Previous pulmonary embolism</td>
<td>1 (1.1%)</td>
</tr>
<tr>
<td>History of smoking</td>
<td>26 (29.9%)</td>
</tr>
</tbody>
</table>

CEAP 6 disease. The median duration of symptoms was 12 (IQR 7–60) months. The median body mass index (BMI) was 28.50 kg/m² (SD ±6.31) and only 7 (8.0%) patients had a pre-existing known coagulation disorder. These patients required lifelong anti-coagulation. Seventy-nine (68.7%) limbs had varicose veins with the majority of them (76) having had previous superficial venous ablation. Pre-operative DUS showed deep venous reflux in 63 (54.8%) limbs and CTV showed compression in only 36 (31.3%) limbs.

**Lesion Characteristics**

115 limbs were analysed (left = 76 (66.1%)). The majority of lesions were due to NIVL (97 (84.3%)); the remainder comprised MTS (55 (47.8%)) and PTS (18 (15.7%)). The majority of limbs (66 (57.4%)) had both CIV and EIV lesions. Thrombi were found in only 2 (1.7%) limbs. Both patients with thrombi had an underlying coagulopathy disorder (anti-phospholipid syndrome in 1, and protein S deficiency in the other). Table 2 shows the lesion characteristics for all the patients.

**Procedural Characteristics and Complications**

173 stents were placed in 115 limbs (Sinus Obliquus™ = 63/173 (36.4%); Venovo™ = 46/173 (26.6%); Wallstent™ = 63/173 (36.4%); Zilver Vena™ = 1/173 (0.6%)). The mean operative time was 77.5 (SD ± 40.4) minutes. A median of 1 (IQR 1 – 2) stent was placed per limb. A combination of Sinus Obliquus™ and Venovo™ stents was deployed in 23 (20.0%) limbs. A combination of Sinus Obliquus™ and Wallstent™ was deployed in 12 (10.4%) limbs. Pre-dilatation was employed in all the procedures, and all achieved technical and procedural success. Rivaroxaban (Bayer AG, Leverkusen, Germany) was the post-operative anti-coagulation of choice in 93/115 (80.9%) procedures (Warfarin = 19/115 (16.5%); Dual anti-platelet therapy (DAPT) = 2/115 (1.7%); Apixaban = 1/115 (0.9%)). The median length of hospitalisation was 1 day (IQR 1 – 2). 16/115 (13.9%) procedures had post-operative complications (Post-operative fever = 5/16 (31.3%); asymptomatic bradycardia = 1/16 (6.3%); cellulitis = 2/16 (12.5%); in-stent thrombosis = 5/16 (31.3%); in-stent stenosis = 3/16 (18.8%)).
Patency and Stent Integrity

Overall primary patency rates were 98.2% (112/114), 97.9% (93/95), 95.7% (89/93) and 92.8% (64/69) immediately post-intervention, and at 3, 6 and 12 months respectively. 5/87 (5.7%) patients developed in-stent thrombosis (Day 1 post-procedure = 2/5 (40.0%); 6 months = 2/5 (40.0%); 12 months = 1/5 (20.0%).) 2/5 (40.0%) with in-stent thrombosis had PTS (NIVL = 3/5 (60.0%)). 1/5 (20.0%) patient who developed in-stent thrombosis had underlying coagulopathy (Protein-S deficiency). 3/87 (3.4%) patients developed in-stent restenosis. 6/8 (75.0%) of patients who had in-stent restenosis or thrombosis underwent reintervention. One patient with in-stent thrombosis had a spontaneous resolution of thrombi. Another refused reintervention. Secondary patency rate was 99.1% (114/115) at 6 months. 5/8 (62.5%) that developed loss of stent patency involved Wallstent™ usage. Figure 1 shows the Kaplan-Meier curves for the cumulative patency rates for PTS and NIVL.

Clinical Outcomes

The mean rVCSS decreased from 11.52 (SD ±3.54) at baseline to 5.77 (SD ±2.36) at 3 months (P < 0.01). 59/115 (51.3%) had 350% rVCSS score reduction. 115/115 (100%) limbs experienced 3-point rVCSS score reduction. The mean VAS score decreased from 6.62 (SD ±1.93) to 2.92 (SD ±1.50) at 3 months (P < 0.01). 2/115 (1.7%) had no improvement in VAS pain score. One of these patients had no pain (VAS score = 0) at baseline. No patient experienced an increase in VAS pain score. 41/43 (95.3%) venous ulcers healed completely over a median time of 169 days (IQR 120–253). Of the 2 patients who did not experience ulcer healing, I had in-stent restenosis detected on DUS at 12 months post-intervention and was re-intervened on but still has a small chronic wound. Figure 2 shows the clinical improvement of a patient with bilateral CEAP 6 disease 6 months post-intervention.

Discussion

At our centres, an overwhelming majority of the limbs (84.3%) presented with NIVLs rather than PTS, despite previously reported increased frequency rates of acute DVT in Singapore.24 Most existing studies report a lower proportion of NIVLs. A study conducted by Raju et al reported that slightly more than half (53.0%) of IFVO were NIVLs.25 A smaller study of 200 patients reported just under half of them (48.5%) had NIVLs.7 This is likely to be due to a local referral pathway issue. At our centres, PTS patients were initially managed by haematologists. Patients underwent trials of graduated external compression stockings, venoactive drugs and exercise training programmes.26 Only those with severe refractory venous insufficiency despite medical therapy were referred to vascular surgeons for evaluation.

In our study, nearly half (47.8%) of the limbs had MTS. The true prevalence of MTS is unknown. It is estimated to be present in 2% to 5% of patients with lower limb venous disease.27–29 May and Thurner found spur-like projections in the left common iliac vein in 22% of 430 cadavers examined.2 MTS is underdiagnosed, possibly due to its diagnostic difficulty and permissive role in chronic venous disease.28 MTS is often asymptomatic, until an additional insult or pathology is superimposed, such as cellulitis or osteoarthritis of the knee resulting in loss of the venous calf pump mechanism.25,30 A small prospective study on 20 asymptomatic volunteers who underwent angiography of the iliac veins found that 80% had at least 2 signs indicative of MTS.31 At our centres, asymptomatic patients with MTS did not undergo prophylactic IVUS and deep vein stenting.

All patients underwent DUS to rule out acute deep vein thrombosis and identify the presence of deep vein reflux. Just slightly more than half (54.8%) of the limbs showed deep vein reflux on DUS, suggesting that deep vein reflux is not necessary for diagnosing IFVO. Pre-operative CTV or MRV was performed for all patients to rule out obvious extrinsic causes of compression such as tumours, fibroids or a distended bladder. CTV and MRV provided a clearer visualisation of anatomic compression sites and collaterals, which indicates the hemodynamic significance of the stenosis.32 However, IVUS is the gold standard for diagnosis of obstructive ilio-femoral venous lesions.33,34 Only 36 (31.3%) limbs with IVUS-proven IFVO showed signs of compression on pre-operative CTV or MRV. The absence of compression on CTV or MRV does not exclude underlying IFVO. IVUS is also superior to multi-planar catheter-based venography (MPV) (Figure 3). The VIDIO trial reported that IVUS was significantly more sensitive than MPV in identifying and characterising venous lesions.35 IVUS triumphs MPV in predicting clinical improvement post-stenting.36 IVUS is also an invaluable aid in the accurate placement of venous stents after venoplasty, especially around the ilio-caval confluence.33

Short-term stent patency rates were favorable. Secondary patency rate was 99.1% at 6 months, with minimal reinterventions. PTS patients had lower stent patency rates compared to NIVL patients, consistent with existing studies. A meta-analysis of 1500 patients...
Fig. 1. Kaplan-Meier Curves for Stent Patency Rates in PTS vs NIVL Patients

<table>
<thead>
<tr>
<th>No. of limbs at risk</th>
<th>3 months</th>
<th>6 months</th>
<th>12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTS</td>
<td>16</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>NIVL</td>
<td>79</td>
<td>76</td>
<td>57</td>
</tr>
</tbody>
</table>

Fig. 2. Pre-operative and Post-operative Clinical Picture of a Patient with Bilateral CEAP 6 Venous Disease. **A**, Pre-operative clinical picture demonstrating bilateral limb swelling, diffused venous skin changes and venous stasis ulcers. **B**, Clinical picture of bilateral limbs 6 months post-operation, demonstrating significant alleviation of symptoms.
Fig. 3. Pre-operative and Post-operative Imaging of a Patient with Left Common Iliac Vein (Origin and Confluence) Lesions. A, Pre-operative venography demonstrating obstruction. B and C, Pre-operative IVUS demonstrating obstruction at origin and confluence of left common iliac vein respectively. Obstruction is better visualized on IVUS. D, Post-operative venography demonstrating a good result with no residual obstruction. E and F, Post-operative IVUS shows well expanded stent with adequate lumen at origin and confluence of left common iliac vein respectively.
revealed stent patency rates of 90–100% for NIVLs compared to 74–89% for PTS patients.\textsuperscript{37} Contributing factors affecting stent patency rates include stents terminating below the inguinal ligament, long length of stents and presence of thrombophilia.\textsuperscript{38} No stent fractures or stent migration were experienced in our series. Five out of 8 (62.5\%) instances of loss of stent patency involved Wallstent\textsuperscript{TM} (Boston Scientific, Marlborough, USA). The Wallstent\textsuperscript{TM} is not a dedicated venous stent. It has less radial force at its ends, and significant foreshortening during the post-dilatation process, making it difficult to predict final positioning especially near the ilio-caval junction. Medium term follow-up has shown compressive effects typically at the iliac confluence area.\textsuperscript{39} We have now stopped deploying the Wallstent\textsuperscript{TM} for the last 3 years. Currently, Venovo\textsuperscript{TM} (BD Medical, Arizona, USA) and Sinus Obliquus\textsuperscript{TM} (Optimed, Ettlingen, Germany) are deployed as the stents of choice. The Venovo\textsuperscript{TM} venous stent system comprises a self-expandable nitinol stent that is uniquely flexible for venous vessels, with flared ends to ensure adequate wall apposition.\textsuperscript{40} Sinus Obliquus\textsuperscript{TM} is the first oblique venous stent, specifically designed for treating venous obstructions close to the bifurcation of the IVC, such as in MTS. The oblique design enables the stent to be placed directly at the bifurcation. Similar to our experience, data from the Arnsberg venous registry revealed favourable short-term patency rates for both stents. Primary and secondary patency rates were 97\% and 100\% at 6 months post-intervention for Venono\textsuperscript{TM} stents.\textsuperscript{41} Primary and secondary patency rates were 94\% and 96\% at 12 months post-intervention for Sinus Obliquus\textsuperscript{TM} stents.\textsuperscript{42} Both stents were associated with statistically significant improvement in clinical outcomes and low complications rates. The ongoing VERNACULAR trial on the Venovo\textsuperscript{TM} stent also reported excellent primary patency of 83\% rates at 24 months post-intervention, with no stent fractures.\textsuperscript{42}

While there are innumerable studies reporting excellent patency rates and clinical outcomes following deep vein stenting for IFVO, the quality of evidence is low.\textsuperscript{43–45} Most available studies are small, retrospective, single-site evaluations.\textsuperscript{46} A systematic review conducted by Seager \textit{et al} identified no randomised controlled trials, cohort studies or case-control studies. A GRADE assessment\textsuperscript{47} demonstrated the quality of the evidence to be “low” for ulcer healing and “very low” for other outcomes.\textsuperscript{44} Despite the weak quality of evidence, deep vein stenting is relatively effective and safe with low incidence of peri-operative complications and high patency rates,\textsuperscript{8,43–46} and should be considered as a treatment option while the evidence base improves.\textsuperscript{54}

Post-operative anticoagulation decreases complication rates such as in-stent thrombosis. However, there is no official recommendation on the choice of anticoagulation and the duration of therapy post-procedure.\textsuperscript{16,48} Vitamin K Antagonists (VKA) are the most commonly used agents, but there is a major shift towards the use of Direct Oral Anticoagulants (DOACs) recently.\textsuperscript{49} At our centres, Rivaroxaban (Bayer AG, Leverkusen, Germany) was the anticoagulation of choice in 93/115 (80.9\%) procedures, due to its ease of use and low complication rates. Rivaroxaban has minor drug and food interactions, a wide therapeutic window, and no need for laboratory monitoring.\textsuperscript{50} Rivaroxaban has a lower incidence of major bleeding. At our centre, only 1 case of intra-cerebral bleed was observed. All PTS patients were prescribed warfarin. Anti-coagulation was discontinued and replaced with aspirin 6 months after stenting for NIVLs, if DUS surveillance was satisfactory. Patients with a history of recurrent DVTs or coagulation disorders usually maintain lifelong anticoagulation. Our practice is consistent with the international consensus achieved using Delphi methodology in the first-ever study investigating antithrombotic practices after venous stenting—52/61 (85.2\%) of the study respondents discontinued anticoagulation 6–12 months post-stenting for NIVLs. 51/60 (85.0\%) started lifelong anticoagulation for PTS. \textit{VKA} are the most commonly used agents, but there is a major shift towards the use of Direct Oral Anticoagulants (DOACs) recently.\textsuperscript{50} Rivaroxaban has a lower incidence of major bleeding. At our centre, only 1 case of intra-cerebral bleed was observed. All PTS patients were prescribed warfarin. Anti-coagulation was discontinued and replaced with aspirin 6 months after stenting for NIVLs, if DUS surveillance was satisfactory. Patients with a history of recurrent DVTs or coagulation disorders usually maintain lifelong anticoagulation. Our practice is consistent with the international consensus achieved using Delphi methodology in the first-ever study investigating antithrombotic practices after venous stenting—52/61 (85.2\%) of the study respondents discontinued anticoagulation 6–12 months post-stenting for NIVLs. 51/60 (85.0\%) started lifelong anticoagulation for PTS. A Taiwanese study revealed that mutations at position 467 in the prothrombin gene, a form of inherited thrombophilia, is extremely rare in Chinese.\textsuperscript{53}

Conclusion

In our series, the majority of patients requiring deep vein stenting presented with NIVLs rather than PTS, which may be a referral pathway issue. Deep vein stenting of symptomatic IFVO was associated with low complication rates and excellent short-term primary patency rates, with few re-interventions. There was marked improvement in clinical outcomes at 3 months, with a high and expedient venous ulcer healing rate.
However, rigorous evaluation of safety and long-term effectiveness of deep vein stenting with novel dedicated venous stents is required. Further studies are necessary to optimise post-operative anticoagulation regimes.

REFERENCES


