

Long-term outcomes following use of a composite Wallstent-Z stent approach to iliofemoral venous stenting

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ABSTRACT

Objective: An endovascular approach has essentially replaced open surgery in the management of symptomatic chronic obstructive iliofemoral venous disease. In the last several years, such a minimally invasive approach has shifted from use of Wallstents alone to a combination of Wallstent-Z stent (composite stenting) to better deal with the ilio caval confluence. This study evaluates the clinical and stent related outcomes following use of composite stenting.

Methods: A retrospective review of contemporaneously entered EMR data on 535 patients (545 limbs) with initial iliofemoral stents placed over a 4-year period from 2014 to 2017 for symptomatic chronic iliofemoral venous obstruction was performed. Patients who underwent stenting after intervention for acute deep venous thrombosis were excluded. The impact of stenting on clinical outcomes before and after the intervention were evaluated through use of the visual analog scale pain score (0-10), grade of swelling (0-4), and Venous Clinical Severity Score (0-27). Quality of life was appraised using the Chronic Venous Disease quality of life Questionnaire 20 instrument. Kaplan-Meier analysis was used to assess primary, primary assisted and secondary stent patencies, and paired and unpaired *t*-tests were used to examine clinical outcomes.

Results: Of the 545 limbs that underwent stenting, 183 were in men and 362 were in women. The median age was 60 years. Laterality was right in 205 limbs and left in 340 limbs. Post-thrombotic syndrome was seen in 441 limbs and nonthrombotic iliac vein lesions/May-Thurner syndrome in 104 limbs. At 24 months, visual analog scale pain score went from 5 to 2 ($P < .0001$), grade of swelling went from 3 to 1 ($P < .0001$), and Venous Clinical Severity Score went from 6 to 4 ($P < .0001$). Ulcers were present in 67 limbs and had healed in 49 limbs (73%) over a median follow-up of 26 months. Global Chronic Venous Disease quality of life Questionnaire scores improved from 60 to 36 ($P < .0001$) after stenting. Cumulative primary, primary-assisted, and secondary patencies at 60 months were 70%, 99% and 91%, respectively. Thirty limbs (5.5%) required contralateral stenting. There was only one instance (0.2%) of contralateral iliofemoral deep venous thrombosis. One hundred eleven limbs (20%) underwent reintervention, including for in-stent restenosis in 44 limbs, stent compression in 2 limbs, in-stent restenosis and stent compression in 48 limbs, and stent occlusion in 17 limbs.

Conclusions: In patients undergoing iliofemoral venous stenting for obstructive disease, clinical improvement, quality of life improvement, and stent patencies after use of a composite stent configuration are comparable with those seen after exclusive use of Wallstents. However, the use of a composite stent configuration not only decreases the need for contralateral stenting to relieve chronic obstruction, but also decreases the incidence of contralateral iliofemoral deep venous thrombosis. (J Vasc Surg: Venous and Lym Dis 2021;9:393-400.)

Keywords: Iliac vein stenting; May-Thurner syndrome; Nonthrombotic iliac vein lesion; Chronic iliofemoral venous obstruction; Post-thrombotic syndrome

Minimally invasive interventions have revolutionized treatment of venous disease over the last few decades. This is especially so in the management of symptomatic chronic iliofemoral venous obstruction (CIVO)

where an endovascular approach has essentially replaced open surgery.¹⁻¹⁰ The last several years has witnessed the shift in this minimally invasive approach from use of Wallstent (Boston Scientific, Marlborough, Mass) alone to a combination of Wallstent and Z stent (Cook Medical, Bloomington, Ind; composite stent). This latter approach enables better handling of the ilio caval confluence.¹¹ Although extensive literature exists regarding technique and outcomes following use of Wallstents alone, long-term results after the use of a composite stent approach have not been assessed. This study evaluates the clinical and stent-related outcomes after use of a composite stent approach in the process offering a standard against which the outcomes of dedicated venous stents that are entering the market can be appraised.

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METHODS

Study design. We conducted a single-center retrospective analysis of prospectively collected data over a 4-year period from 2014 to 2017. Institutional review board approval was obtained for dissemination of deidentified patient data. Patient consent was obtained for the procedure.

Setting. The center is a tertiary center for management of venous and lymphatic disorders.

Participants. Patients who underwent intravascular ultrasound (IVUS) interrogation and subsequent iliac vein stenting for symptomatic CVOs including chronic total occlusions (CTO) formed the study cohort. Patients who underwent stenting after thrombolysis for acute deep venous thrombosis were excluded.

Stenting and follow-up. Stenting was pursued in patients presenting with disabling symptoms, including pain, swelling, heaviness, tiredness, hyperpigmentation, and/or lipodermatosclerosis suggestive of CVO who had evidence of iliac vein obstruction on IVUS examination. The criteria used for the diagnosis of such obstruction involved use of minimal luminal areas in the common femoral (125 mm^2), external iliac vein (150 mm^2), and common iliac vein (200 mm^2).¹² A luminal area below these cut-off points was considered abnormal, meriting stenting in the symptomatic patient.

Access was generally obtained in the mid-thigh femoral vein under ultrasound guidance and a 11F, 10-cm sheath placed. A venogram was typically performed unless there was a contraindication. IVUS interrogation (Visions PV .035 digital IVUS catheter; Philips, Amsterdam, the Netherlands) was then carried out and the diagnosis confirmed using the criteria mentioned above. Predilation was pursued prior to stenting usually using a 16 or 18 mm angioplasty balloon inflated to a pressure above nominal where equilibration occurs. Stenting was then accomplished using a composite stent configuration of a Wallstent body and a Z stent top (Fig 1). This composite stent configuration provides additional radial-resistive force across the ilio caval choke point obviating the need for Wallstent extension well into the cava in the process preventing jailing of the contralateral side. Stents used typically ranged from 16 to 20 mm diameter for the Wallstent and 25 to 30 mm for the Z stent. The goal was to cover all areas of disease with adequate overlap (2-3 cm) between stents to prevent shelving. Extension into the vena cava was about 1 to 2 mm for the Wallstent and up to 20 mm for the Z stent. The deployment of the Z stent required the swap of the 11F sheath to a 14/16F Shuttle sheath (Cook Medical, Bloomington, Ind) for deployment of a 25- or 30-mm Z stent, respectively. Caudally stent extension was carried out into an area of good inflow as determined by IVUS interrogation. In an overwhelming majority (>80%) this involved extension into the common femoral vein. Such extension

ARTICLE HIGHLIGHTS

- **Type of Research:** Single-center, retrospective analysis of prospectively collected data
- **Key Findings:** Use of a composite stent configuration of Wallstent and Z stent in patients requiring iliac vein stenting results in improved outcomes compared to published data from use of Wallstents alone.
- **Take Home Message:** A composite stent configuration of Wallstent and Z stents for iliac vein stenting results in less need for contralateral iliac vein stenting and less contralateral deep vein thrombosis than the use of Wallstents alone.

often-involved placement of two Wallstents given the short lengths of these stents allowing for 2 to 3 cm overlap in addition to the Z stent. After deployment of the Z stent, the 11F, 10-cm sheath was reinserted to pursue after dilation (usually with the same angioplasty balloon used for predilation), completion IVUS interrogation (to ensure adequate luminal areas have been attained) and for the completion venogram. Surgicel fibrillar plug (Ethicon, Somerville, NJ) was inserted into the access tract after withdrawal of the sheath to enable hemostasis. A pressure dressing was then applied over the access site after application of manual pressure to compliment the hemostatic effect.

Antithrombotic therapy was started in the perioperative period and continued for at least for 6 months postoperatively. Preoperatively, this included prophylactic enoxaparin (30-40 mg subcutaneously) and bivalirudin 75 mg. Postoperatively, therapeutic enoxaparin (1 mg/kg/dose subcutaneously every 12 hours) was continued while in the hospital. After discharge, a combination of anticoagulation (direct oral anticoagulant/warfarin), cilostazol, and aspirin 81 mg as long because no contraindications for their use existed. Longer term anticoagulation was continued in patients with thrombophilia or those who developed stent complications (eg, occlusion) after discontinuation of anticoagulation. Aspirin 81 was usually continued lifelong. Post-intervention patients received a pair each of graduated compression stockings (20-30 mm Hg) and of compression wraps with the recommendation to be worn regularly. With regards to postprocedure imaging, duplex ultrasound examination was done on day 1; 2 and 4 weeks; 3 months, 6 months, 1-year postintervention, and yearly thereafter if patients remained asymptomatic without any evidence of stent malfunction. Clinical assessment was carried out at every follow-up visit starting at 6 weeks. Details of technique of stenting, stent sizing and perioperative management have been described in prior publications.^{8,9,12,13}

Measurements. The visual analog scale (VAS) pain score, grade of swelling, and Venous Clinical Severity Score (VCSS; 0-27) were assessed before and after



Fig 1. Composite stent configuration of a Wallstent body and a Z stent top.

then intervention (before stenting and at every follow-up clinic visit). Although the VAS score ranged from 0 for no pain to 10 for the most severe pain; grade of swelling was categorized as 0 (no swelling), 1 (pitting, nonobvious swelling), 2 (visible ankle swelling), 3 (gross swelling involving the leg up to knee), and 4 (gross swelling involving the entire leg including the thigh). Points for compression stockings were excluded from the VCSS, leaving a range from 0 to 27. Quality of life was appraised using the Chronic Venous Disease quality of life Questionnaire (CIVIQ) 20 instrument with a score of 100 indicating the worst possible quality of life and a quality of life of 0 indicating the best possible quality of life.^{14,15} Pain, social, physical, and psychological domains were individually considered in addition to generation of a global score. The last available response was used in postoperative outcome analysis.

Reintervention. During the course of follow-up if patients developed recurrence of initial symptoms on the previously stented side, they underwent IVUS interrogation and correction of the etiology of stent malfunction. The latter included in-stent restenosis (ISR), stent compression (SC), combination of ISR and SC or stent occlusion. In contrast, if they developed disabling contralateral symptoms then they underwent IVUS interrogation and stenting of the opposite side as indicated. Technique of contralateral stenting involves allowing the Z stent petals/struts to flower by cutting the cranial nylon suture after partially unsheathing the stent and resheathing it again. Such flowering enables easy interdigitation of the struts of Z stents on both sides without compromising outflow on either side (Fig 2). Details of this technique of composite iliac vein stenting has been previously described.¹¹

Statistical analysis. Statistical analysis was performed using Prism GraphPad 6 (GraphPad Software, San Diego, Calif). Paired and unpaired *t*-tests were used to examine clinical outcomes pre and post intervention outcomes. Kaplan-Meier analysis was used to assess primary, primary assisted and secondary stent patencies. A *P* value of less than .05 was considered significant.

RESULTS

Of the 545 limbs (535 patients) that underwent stenting, 362 were in women and 183 were in men. The median age was 60 years. Laterality was right in 205 limbs and left in 340 limbs. There were 10 patients who underwent simultaneous bilateral stenting, including 8 for bilateral CTO and 2 for severe bilateral symptoms. Post-thrombotic syndrome (PTS) was the noted etiology in 441 limbs (including 40 CTO), whereas nonthrombotic iliac vein lesions (NIVL) were noticed in 104 limbs. With regard to CEAP scores, there were 6 (1%) C0 patients, no C1 patients, 6 (1%) C2 patients, 155 (28%) C3 patients, 299 (55%) C4 patients, 24 (4%) C4 patients, and 55 (10%) C6 patients. Patients with CEAP scores of 0 and 2 ($n = 12$) underwent intervention secondary to disabling venous claudication. The median follow-up in the study was 26 months. Of the 545 limbs that underwent stenting, 43 underwent additional one-vessel endovenous laser ablation for saphenous reflux. There were no other secondary procedures at the time of the initial stenting.

Clinical outcomes

VAS pain score. VAS pain score data was available for 248, 284, and 201 limbs at 6, 12, and 24 months, respectively. Improvement in the VAS pain score (baseline 5) to 0 was seen at 3 months ($P < .0001$), remained at 0 at 6 months ($P < .0001$), went to 1 at 12 months ($P < .0001$), and to 2 at 24 months ($P < .0001$).

Grade of swelling. Grade of swelling improved (baseline 3) to 1 at 3 months ($P < .0001$), remained so at 6 months ($P < .0001$), at 12 months ($P < .0001$), and at

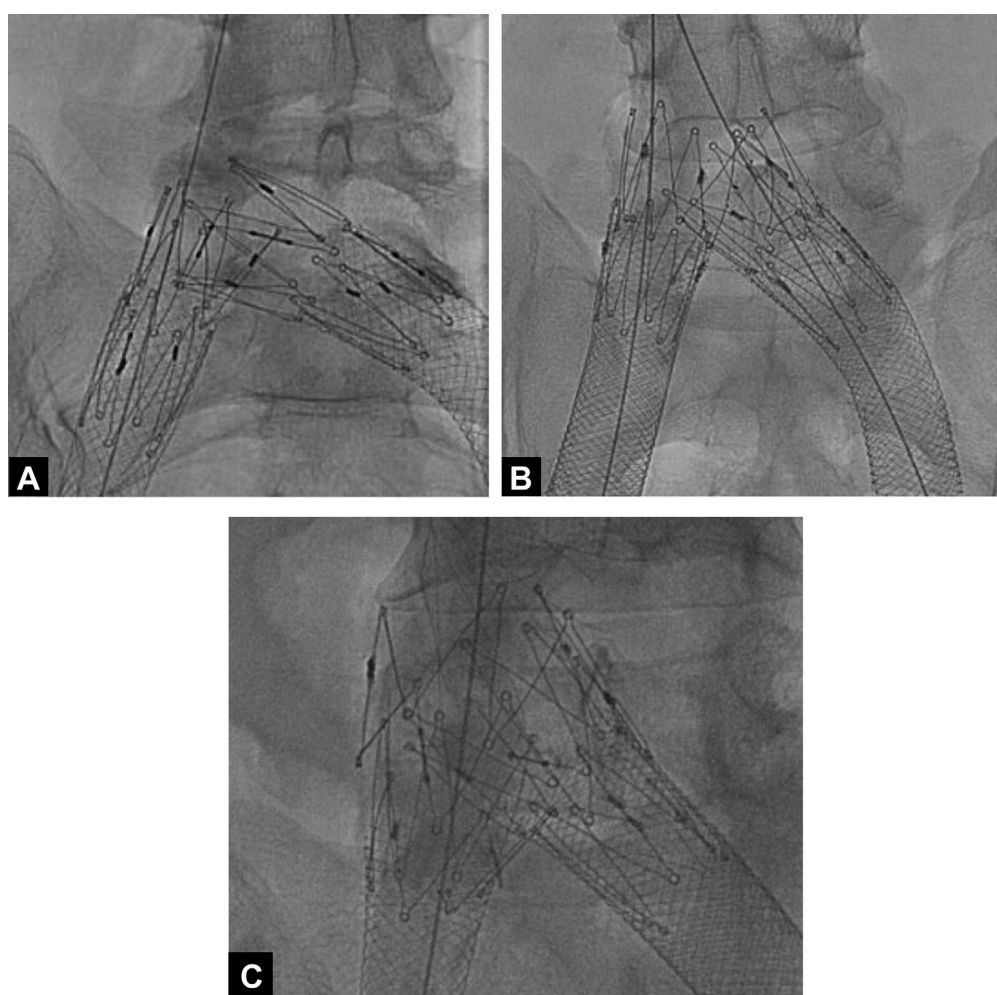


Fig 2. A-C, Examples of iliac vein confluence stenting using a composite stent configuration. **A,** Represents a more tortuous left common iliac vein than **(B)**. **C,** Depicts extensive interdigitation between the petals of the right and left Z stents.

24 months ($P < .0001$), based on data available for 177, 212, and 145 limbs at 6, 12, and 24 months, respectively.

Of the 427 limbs that had pain and/or swelling for whom data were available, complete relief of pain and/or swelling was noted in 256 of 427 limbs (60%). Partial relief of pain and/or swelling was noted in 104 of 427 limbs (25%). Of the remaining limbs, 64 of the 427 (approximately 15%) had no improvement, but also no worsening over the duration of follow-up. Three limbs worsened over the follow-up period. Recurrence of pain and/or swelling after initial complete resolution of these symptoms is considered in Fig 3. Of the 256 limbs, although 73% had recurrent symptoms at 5 years, only 56 (22%) limbs required reintervention secondary to disabling symptoms.

VCSS. VCSS improved (baseline 6) to 4 at 3 months ($P < .0001$) and remained at 4 at 6 months ($P < .0001$), 12 months ($P < .0001$), and 24 months ($P < .0001$). VCSS data were available for 247, 283, and 200 limbs at 6, 12, and 24 months of follow-up, respectively.

Ulcer healing. Ulcers were present in 67 limbs and healed in 49 limbs (73%) over the duration of the

follow-up period. Six limbs developed recurrent ulcers. Overall, there was an ulcer recurrence rate of 34% at 5 years. The median time to ulcer recurrence was 23 months.

Contralateral iliac vein thrombosis

There was only 1 instance among 541 limbs (0.2%) of contralateral iliofemoral deep venous thrombosis after the use of the composite stent configuration.

Quality of life. The CIVIQ-20 instrument was used to evaluate quality of life before and after stenting. These data were available for 110 patients and are considered in Table. A statistically significant improvement in median scores after stenting was noted across the pain, social, physical, and psychological domains. The median global score improved, going from 60 before the intervention to 36 after stenting ($P < .0001$).

Stent outcomes

Patency. At 60 months, although the overall primary patency was 70%, primary-assisted patency was 99% and secondary patency was 91% (Fig 4, A). For limbs with NIVL, the primary patency at 60 months was 74%, and

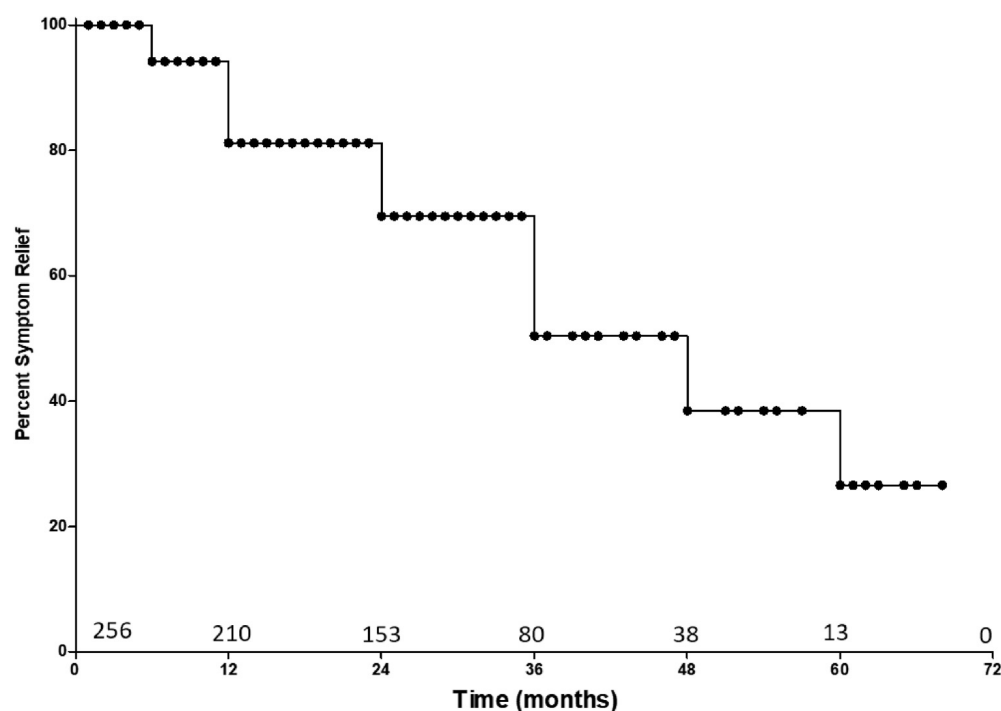


Fig 3. Plot depicting the recurrence of any pain and/or swelling after stenting (the standard error of the mean was <10%).

the primary-assisted patency was 100% (Fig 4, B). Secondary patency could not be calculated because there were no stent occlusions in this group. For post-thrombotic limbs, the primary patency at 60 months was 68%, primary-assisted patency was 99%, and secondary patency was 88% (Fig 4, C). For CTO, patencies after recanalization at 60 months included a primary patency of 81% and secondary patency of 100% (Supplementary Fig 1, online only). There were no interventions for ISR and/or SC hence no primary-assisted patency.

Reintervention. There were 111 limbs (20%) that underwent reintervention, including for ISR in 44 limbs, SC in 2 limbs, ISR and SC in 48 limbs, and stent occlusion in 17 limbs. Of the 17 stent occlusions, 7 (41%) occurred within 30 days of stent placement and the remainder beyond that time frame. Five patients had CTO lesions and the remainder had stenotic lesions secondary to PTS.

Table. Chronic Venous Disease quality of life Questionnaire (CIVIQ) instrument median domain and global scores pre and post iliofemoral venous stenting

CIVIQ domain	Prestenting score	Poststenting score	P value
Pain	56	38	<.0001
Social	50	25	<.0001
Physical	62	41	<.0001
Psychological	61	35	<.0001
Global	60	36	<.0001

Contralateral stenting. Contralateral stenting was required in 30 limbs (5.5%) secondary to a lack of improvement after ipsilateral stenting or worsening after initial improvement.

Procedure-related complications. Procedure-related hemorrhage requiring transfusion of blood products were noted in five patients. Pseudoaneurysms occurred in four limbs (three required ultrasound guided thrombin injection and one closed spontaneously). An arteriovenous fistula was observed in one limb and managed conservatively. Additionally, there was a superficial femoral artery injury that required placement of a covered stent. No deaths occurred.

DISCUSSION

Ilio-femoral venous stenting represents the current paradigm for management of symptomatic chronic deep venous obstruction. Until recently, most experience was through the use of Wallstents with extension up to the contralateral caval wall to prevent recurrent compression/caudal migration of the Wallstent. However, this technique brought with it problems relating to jailing of the contralateral common iliac vein outflow, including contralateral iliac vein thrombosis.^{16,17} To overcome these problems and those arising secondary to poor physical properties of the terminal segment of the Wallstent, the Z stent was used. The large interstices of this stent in addition to its excellent radial-resistive force can potentially help to maintain the strengths of the Wallstent at the same time overcoming its shortcomings.

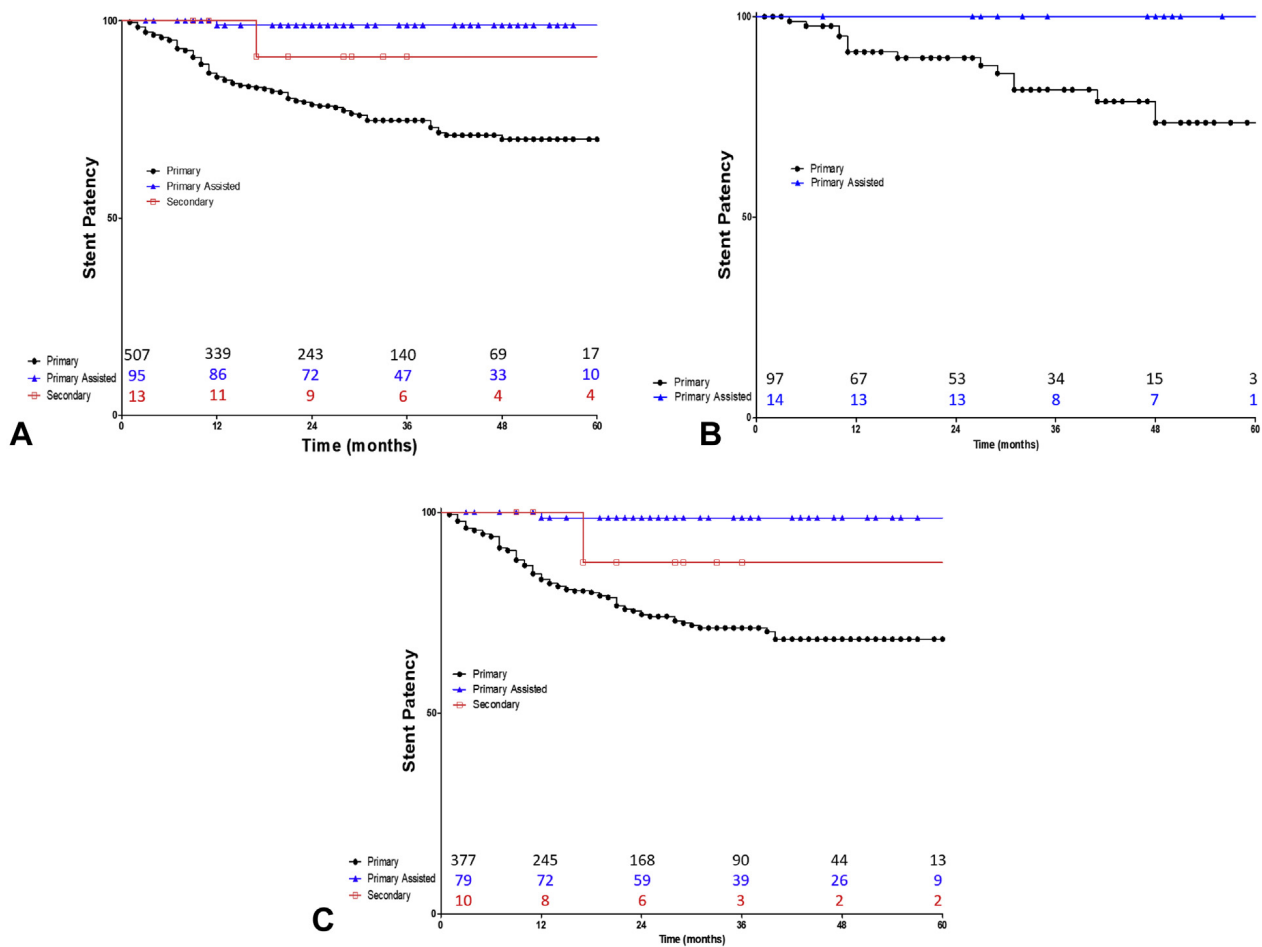


Fig 4. **A**, Plot demonstrating overall stent patencies (the standard error of the mean was <10%). **B**, Plot demonstrating stent patencies for limbs with nonthrombotic iliac vein lesions (N/IL; the standard error of the mean was <10%). **C**, Plot demonstrating stent patencies for PTS limbs (the standard error of the mean was <10%).

This study has sought to pin outcome metrics to these theoretical advantages in the process, enabling a data-driven approach to the use of the composite stent configuration. In the process, it also provides baseline parameters against which dedicated venous stents can be compared.

Comparison of clinical improvement after stenting.

Clinical improvement after composite stenting was noted to be sustained with continued improvement at 24 months. This outcome was particularly true for the VCSS and the grade of swelling. With regard to the VAS pain score, there was recurrence of mild pain at 12 months that remained at 24 months. Complete relief of pain and/or swelling was noted in 256 of 427 limbs (60%). Partial relief of pain and/or swelling was noted in 104 of 427 limbs (25%). For pain alone, complete relief was noted in 206 of 333 limbs (62%) and for swelling alone complete relief was seen in 133 of 427 limbs (31%). This result compares with 62% (complete relief of pain) and 32% (complete relief of swelling) with use of Wallstents alone.⁸ Ulcer healing was noted in 73% of patients who initially presented with an ulcer. Of

these patients, 66% remained without ulcer recurrence at 5 years. This compares with a 58% ulcer healing rate over 5 years noted with use of Wallstents alone, with an ulcer recurrence-free rate of approximately 50% (over 5 years).⁸ The prevalence of contralateral iliofemoral venous thrombosis in the composite stent cohort was 1 of 535 (0.2%). Although this patient had no history of thrombophilia, she had been placed on warfarin secondary to severe PTS changes noted during stent placement. However, for unclear reasons, this medication was stopped before her developing contralateral thrombosis, which occurred 31 months after ipsilateral stenting. This incidence of 0.2% compares with the 1% to 10% noted with the use of Wallstents.^{8,16,17} In essence, although clinical outcomes are comparable between the composite stent configuration and isolated use of Wallstents, there is an appreciable difference between the two with regard to the incidence of contralateral deep vein thrombosis (DVT).

Comparison of stent patencies. Overall patencies for the entire cohort was 70% for primary patency, 99% for primary-assisted patency, and 91% for secondary

patency at 60 months. This compares with 67%, 89%, and 93%, respectively, for primary, primary-assisted, and secondary patencies at 72 months for Wallstent alone.⁸ For NIVL, composite stenting revealed primary patency and primary-assisted patency of 74%, and 100%, respectively. With Wallstent alone, previously published data from the practice notes 79%, 100%, and 100% primary, primary-assisted, and secondary patencies at 72 months, respectively. With regard to PTS limbs, primary, primary-assisted, and secondary patencies of 68%, 99%, and 88%, respectively, at 60 months with use of composite stenting, whereas with Wallstent alone, they were 57%, 80%, and 86%, respectively, at 72 months. Patencies after recanalization of CTO had primary and secondary patencies of 81% and 100% at 60 months with use of a composite stent configuration, whereas with Wallstents alone, these patencies were 54% and 74%, respectively, at 48 months. Although there is a difference in the time length at which patencies were calculated for the two stent configurations, given the good patencies noted at 60 months with use of the composite stent configuration it is not unreasonable to expect continued good patencies with the composite stent configuration. Overall patencies seem to be comparable with the use of Wallstents alone.

Reintervention. Reintervention was pursued in 111 limbs (20%) in this composite stent cohort. These included for ISR in 44 limbs (8%), SC in 2 limbs (0.4%), ISR and SC in 48 limbs (8.6%), and stent occlusion in 17 limbs (3%) (all had PTS). Previously published data note a reintervention rate of 180 in 982 (18%) in the Wallstent alone cohort. The reasons for reinterventions in the latter cohort include angioplasty for ISR in 56 limbs (6%), stent extension (cranial, caudal, stent separation) to treat previously unidentified stenosis in 80 limbs (8%), a combination of the two in 13 limbs (1%) and stent occlusion in 31 limbs (3%).⁸ There is some subtle variation in these numbers across the two stent configurations. These variances are more likely due to maturation of the practice and clearer identification of pathology than actual differences between indications for reintervention. Of the 17 stent occlusions in the composite stent cohort, 7 (41%) occurred within 30 days of stent placement and the remainder beyond that time frame. Neglen et al^{8,18} reported a prevalence of 8 of 31 (26%) of acute stent thrombosis (<30 days) with exclusive use of Wallstent. Here again, there is not a lot of difference between reintervention rates or reasons for reintervention between the use of a composite stent configuration and use of Wallstents alone.

Contralateral intervention. Contralateral intervention can be in the form of pharmacomechanical thrombectomy or catheter-directed thrombolysis for acute iliofemoral DVT or iliofemoral venous stenting for symptoms of chronic venous insufficiency secondary to venous hypertension. Both develop owing to jailing of the contralateral

common iliac vein outflow, the former possibly from acute thrombosis of the residual outflow tracts within or around the Wallstent. The latter signifies a patent outflow channel either through the interstices of the Wallstent or around it or both, but still impaired enough to allow for the development of venous hypertension. This chronic manifestation after jailing of contralateral common vein outflow is not well-described, but seems to be more common than the acute finding. The incidence of contralateral iliofemoral DVT from use of Wallstent has ranged from 1% to 10%, as noted elsewhere in this article. With use of composite stenting, this acute problem was noted in only 0.2% of the study cohort. This result represents a sizeable difference and is likely due to the large interstices of the Z stent that prevents limitation of contralateral common iliac vein outflow. With regard to intervention in a more chronic setting, previously published data have demonstrated that, with exclusive use of Wallstents, the occurrence of contralateral iliac vein stenting is approximately 13%.^{8,18} In this study cohort, we noted that 30 patients (5.5%) required contralateral stenting. Here again, the relative absence of jailing and lack of compromise of contralateral common iliac vein outflow with the composite stent configuration is what prevents an iatrogenic iliac vein obstruction and consequent development of venous hypertension. The technique of contralateral stenting with use of bilateral Wallstent body and Z stent top has been considered earlier. At times successful recanalization of CTO lesions may require extension of the stent column into the IVC. **Supplementary Fig 2** (online only) displays the use of a composite stent configuration in this setting. Good outcomes can be expected following contralateral stenting in the appropriate patient.¹⁹

Quality of life comparison. A statistically significant improvement post stenting was noted in the median CIVIQ scores across the pain, social, physical, psychological domains in addition to the global score with use of a composite stent configuration. Such an improvement was also noticed with exclusive use of Wallstents.⁸

Composite stenting vs Wallstent alone. Clinical improvement and stent patencies noted with use of the composite Wallstent- Z stent configuration is not very different from use of Wallstents alone. However, with regard to requirement for contralateral intervention either owing to the development of venous hypertension from chronic outflow obstructive changes or owing to acute contralateral iliofemoral venous thrombosis, there is a noteworthy difference. In this study cohort, the occurrence of contralateral stenting was 5.5%, which is much lower than the 13% noted with use of Wallstent alone. This represents a more than 50% decrease in requirement of contralateral stenting. Again, with regard to contralateral DVT, with use of composite stenting the

incidence was only 0.2% compared with at least 1% (going up to 10%). This represents at least a five-fold reduction in incidence of contralateral DVT in patients undergoing iliac vein stenting using a composite configuration. These are important aspects that highlight the strengths of using a Wallstent-Z stent configuration instead of Wallstents alone.

Limitations of this study include its inherent retrospective and historical comparative nature. The comparison is made against previously published experience from the group. However, this experience does represent one of the largest published data on Wallstent use for chronic femoroiliac obstruction to date. There is also the problem with loss of patients over follow-up. Pre- and post-CIVIQ instrument data were available for only 110 limbs. Still, the study demonstrates definitive advantages offered by use of a composite stent configuration.

CONCLUSIONS

In patients undergoing iliofemoral venous stenting for obstructive disease, clinical improvement and stent patencies after the use of a composite stent configuration are comparable with those seen after exclusive use of Wallstents. However, use of the composite stent configuration not only decreases the need for contralateral stenting from chronic obstruction, but also decreases the incidence of contralateral iliofemoral deep venous thrombosis. This result argues for the use of a composite stent configuration in patients undergoing iliofemoral venous stenting as opposed to Wallstents alone and offers a benchmark for comparison of outcomes after the use of newer dedicated venous stents.

AUTHOR CONTRIBUTIONS

Conception and design: AJ

Analysis and interpretation: AJ, CN, SR

Data collection: AJ, CN, RK

Writing the article: AJ, CN, RK

Critical revision of the article: AJ, SR

Final approval of the article: AJ, CN, RK, SR

Statistical analysis: CN

Obtained funding: Not applicable

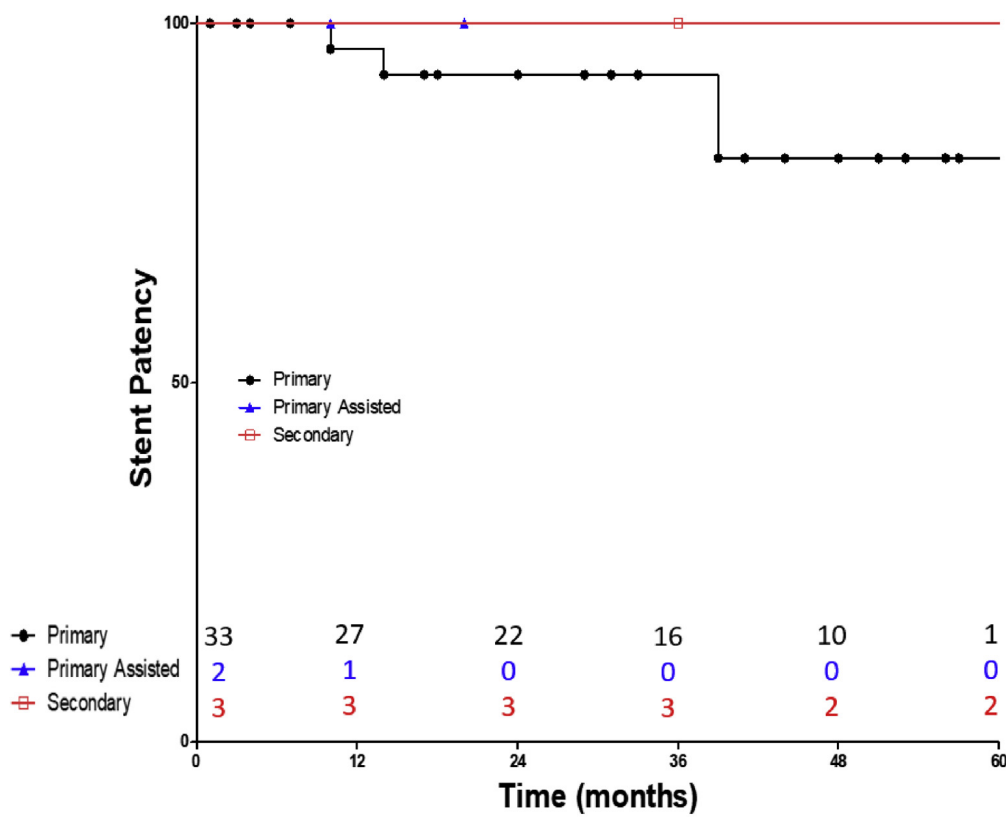
Overall responsibility: AJ

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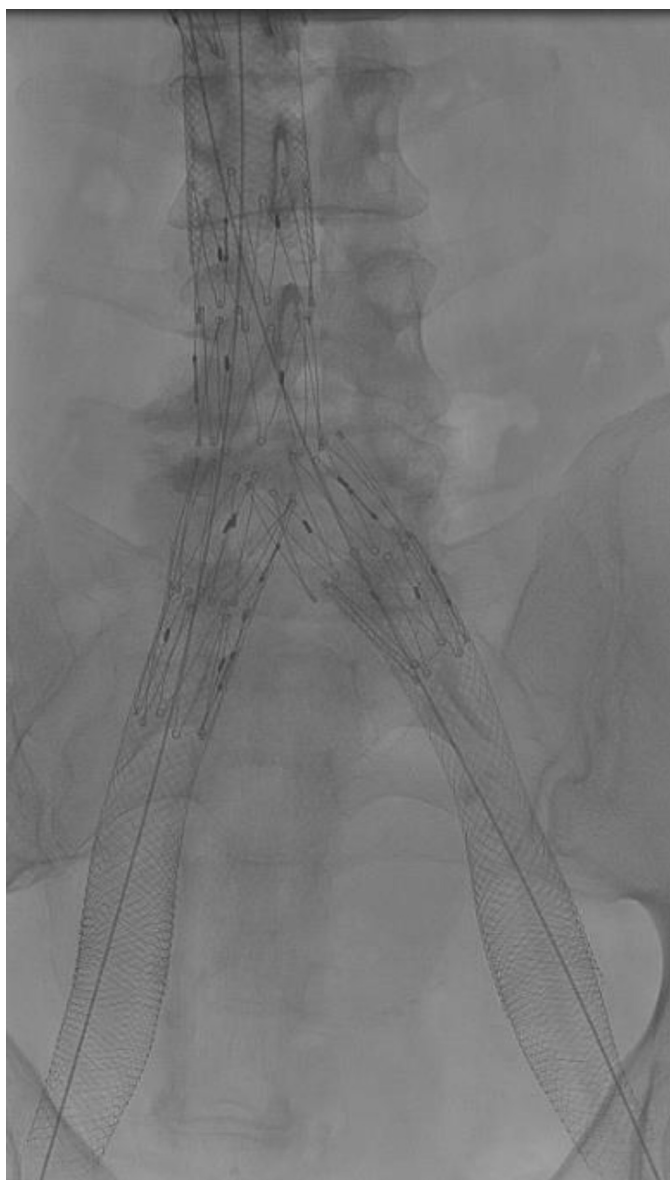
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Supplementary Fig 1 (online only). Plot demonstrating stent patencies for limbs with chronic total occlusions (CTO; the standard error of the mean was <10%).



Supplementary Fig 2 (online only). Composite stent configuration with extension into the inferior vena cava for bilateral ilio caval chronic total occlusive (CTO) lesions.