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Extension of iliac vein stent into the profunda femoral vein for salvage

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ABSTRACT

Background: The extension of iliac vein stents into the common femoral vein is often required to correct stenoses found at or near the inguinal ligament. Very rarely, an extension of the iliac stent into the profunda femoris vein may be required because of severe disease at the femoral trijunction. Profunda extension of iliac vein stents is a rare but useful technique for salvage. Our experience with extensions of iliac vein stents into the profunda femoris vein is described.

Methods: A search of our electronic medical records identified 20 limbs (0.75%) among a total of 2641 stented limbs (years 2006-2017) in whom the iliac vein stent was extended into the profunda femoris vein. Patients had been followed at 6 weeks, 3 months, 6 months, and yearly thereafter following the index procedure. Routine follow-up consisted of a detailed clinical evaluation, including the Venous Clinical Severity Score, visual analogue pain scale assessment, and edema grading by physical examination. Stent surveillance was performed at the follow-up visits. The iliac vein stent was declotted if needed and then extended into the profunda femoris vein at the same sitting. Antegrade access of the profunda femoris vein was preferred by direct puncture near the lesser trochanter or through a popliteal approach when a profunda-popliteal connection was present. An internal jugular access was used when an antegrade approach failed.

Results: Stent extension into the profunda was a secondary procedure after the initial iliac-common femoral vein stent failed in 17 of 20 limbs (85%). In three limbs (15%), the profunda extension was carried out at the initial iliac vein stent procedure because there was severe stenosis at the femoral confluence. One or more reinterventions after profunda extension were required in 50% of the limbs to maintain secondary patency or functionality. Fifteen of 20 limbs (75%) with profunda extensions remained patent on long-term follow-up. The median duration of secondary patency of stents that remained patent and those that occluded, and overall were 23 months, 3 months, and 10 months, respectively. Thirty percent of stents remained patent at 5 years.

Conclusions: The extension of an iliac vein into the profunda femoris vein is a rarely required but useful procedure for stent salvage and symptom relief. Corrective reinterventions are often required but can result in long term patency extending to many years. (J Vasc Surg Venous Lymphat Disord 2022;10:1059-65.)

Keywords: Iliac vein stent; Profunda femoris; Femoral vein occlusion; Stent extension

The profunda femoral vein is a backup alternative as an inflow source for iliac vein stents when traditional inflow landing sites become unavailable.[1] Like its arterial counterpart in aorta-femoral bypass, the profunda femoris vein can carry all of the normal limb flow despite its smaller size compared with the femoral vein. The deep femoral vein can enlarge to the same size as the femoral vein in surprisingly short time after femoral vein occlusion to become a functional collateral replacement for the femoropopliteal axis.[1]

The technical approach to iliac vein stent extension to the deep femoral vein is, however, cumbersome. For this reason, it is seldom used as the first choice, only serving as an alternate back up. We describe our experience with iliac-deep femoral stenting detailing technical aspects, patency and clinical outcome. This is a single-center retrospective study

METHODS

This was a retrospective review of prospectively entered data into our electronic medical record systems (GEMMS Corp, Indianapolis, IN) of patients with iliac vein stents that were extended into the profunda femoris vein. Twenty limbs underwent deep femoral extension of the iliac vein stent over an 11-year period from 2006 to 2017, representing 0.75% of all new stents performed during that period. Stented patients were followed up at 6 weeks, 3 months, 6 months, and yearly thereafter per our standard surveillance protocol. More frequent interval follow-up was performed in patients with residual or recurrent symptoms.[1] Follow-up consisted of

From The RANE Center for Venous & Lymphatic Diseases.

Author conflict of interest: S.R. reports a US Patent for Venous Stent Design.

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complete clinical evaluation, Venous Clinical Severity Scoring, supplemental pain scoring by visual analog scale, and objective swelling gradation by physical examination (grade 0, none; grade 1, pitting; grade 2, ankle edema; grade 3, gross swelling involving the leg; grade 4, gross swelling involving leg and thigh). Stent patency was examined by duplex ultrasound examination. Venography via popliteal vein injection was performed when duplex indicated recurrent stenosis or occlusion. CTV or MRV was not used in this series.

Technique. The deep femoral vein was accessed in one of three ways. The preferred approach was via the popliteal vein when a popliteal-profunda connection was visible on venography (Fig 1, *A*). The deep femoral vein can be accessed directly with ultrasound guidance near the lesser trochanter (Fig 1, *B*). The deep femoral vein can also be reached through the internal jugular vein (preferably right) or the contralateral femoral vein. The choice of approach was influenced by the work needed to prepare the iliac vein stent for extension into the deep femoral vein. This often involves reopening an occluded iliac vein stent and clearing the common femoral vein for landing into the profunda femoris vein. An antegrade access in the supine position with a short distance to the occluded stent is preferred for this procedure. The internal jugular approach may be more successful in recanalization of chronic stent occlusions of long duration. However, subsequent wire crossing into the profunda femoris is not always successful, resulting in procedural failure. Antegrade access ensures a caudal landing site in the profunda, but the precise landing point of the caudal end of the stent is difficult to control. Retrograde stent delivery from the catheter tip allows more precise placement. Intravascular ultrasound (IVUS) examination, along with venography, aids the procedure. IVUS examination is particularly useful in assessing the nature and extent of initial pathology and optimal distal

ARTICLE HIGHLIGHTS

- **Type of Research:** Single-center retrospective study
- **Key Findings:** Twenty limbs with extension of the iliac vein stent into the profunda femoris vein for salvage were followed long term. Of the 20, 15 (75%) remained patent (30% for >5 years) with clinical relief. Interval reinterventions were required in 10 of 20 limbs (50%) to maintain long-term patency.
- **Take Home Message:** The extension of an iliac vein stent into the profunda femoral vein is a rarely required but useful procedure for stent salvage.

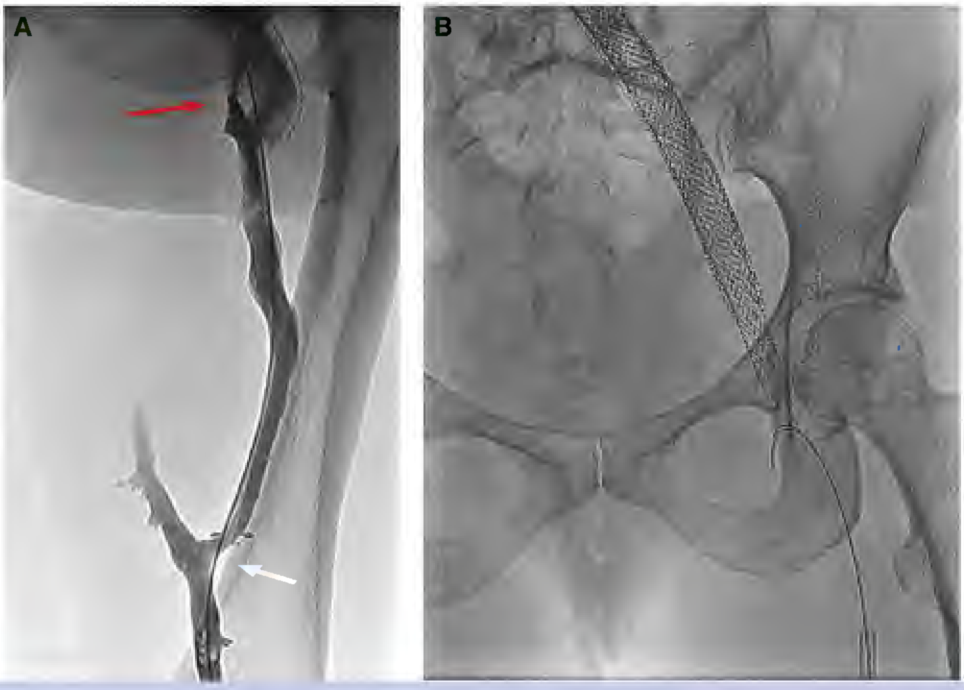

Fig 1. (A) Profunda-popliteal connection (white arrow) is commonly present when the profunda functions as a collateral to compensate for femoral vein disease. The profunda vein can be accessed from the popliteal vein through this connection. The profunda was primarily chosen as the caudal landing site because the common femoral vein was stenotic at the confluence red arrow). **(B)** The profunda femoris was directly accessed under ultrasound guidance near the lesser trochanter in this limb. The bony landmark is a useful guide to the vein.

Table. Clinical outcomes

	Pre	Post	*P* value
Patent stents (limbs) (n = 15)			
VCSS	5.2 ± 2.0	2.4 ± 1.7	.0005
GOS	2.4 ± 1.4	1.0 ± 1.2	.0005
VAS	3.4 ± 3.3	1.2 ± 2.3	.044
Occluded stents (limbs) (n = 5)			
VCSS	5.6 ± 3.0	4.8 ± 2.2	.51
GOS	1.8 ± 1.3	1.8 ± 1.3	>99
VAS	5.0 ± 4.6	1.8 ± 1.0	.26

GOS, Objective swelling gradation; *VAS*, visual analog scale; *VCSS*, Venous Clinical Severity Scoring.

landing site for stent extension into the deep femoral vein. Completion IVUS examination ensures that stent extension is technically satisfactory.

The normal deep femoral vein is approximately 6 mm in diameter, but can enlarge to the same caliber as the femoral vein (approximately 10 mm) when it is occluded.[2] A 10- or 12-mm stent extension into the deep femoral vein should provide adequate inflow into the stent. If a potential size mismatch was likely to result, a smaller caliber balloon than the stent size was used. This process is preferable to using a smaller caliber stent to avoid stent shelving at stent joints. Jailing the first tributary of the profunda that joins it at or near the trijunction is unavoidable. The distal landing site in the profunda femoris should be free of disease. Lesions above the landing site may be balloon dilated but should be stented to prevent recoil or recurrence. Stent placement in a similarly diseased femoral vein is not recommended because they invariably occlude shortly after placement.

Preoperative venography is a poor predictor of ultimate stent patency. Other methods of inflow assessment are also unreliable. As a salvage procedure stent extension into the profunda femoris is a last resort option, performed regardless of the venographic appearance. Informed consent for the various procedures was obtained from patients. Institutional review board permission was granted for publication of this deidentified analysis.

Statistics. A Wilcoxon matched-pairs signed-ranks test was used to evaluate the Venous Clinical Severity Scoring, swelling grade, and visual analog scale. Because of the small sample size, secondary patency with the number of reinterventions are individually shown via bar graphs for both patent and occluded stents. Statistical analysis was performed using a commercial package Prism 9 (GraphPad, San Diego, CA).

RESULTS

The demographics of the patients are shown in the Supplementary Table (online only). The median follow-up duration was 23.5 months with a range of 1 to 155 months. Seventeen of 20 patients presented with occlusion of a previously placed iliac vein stent with

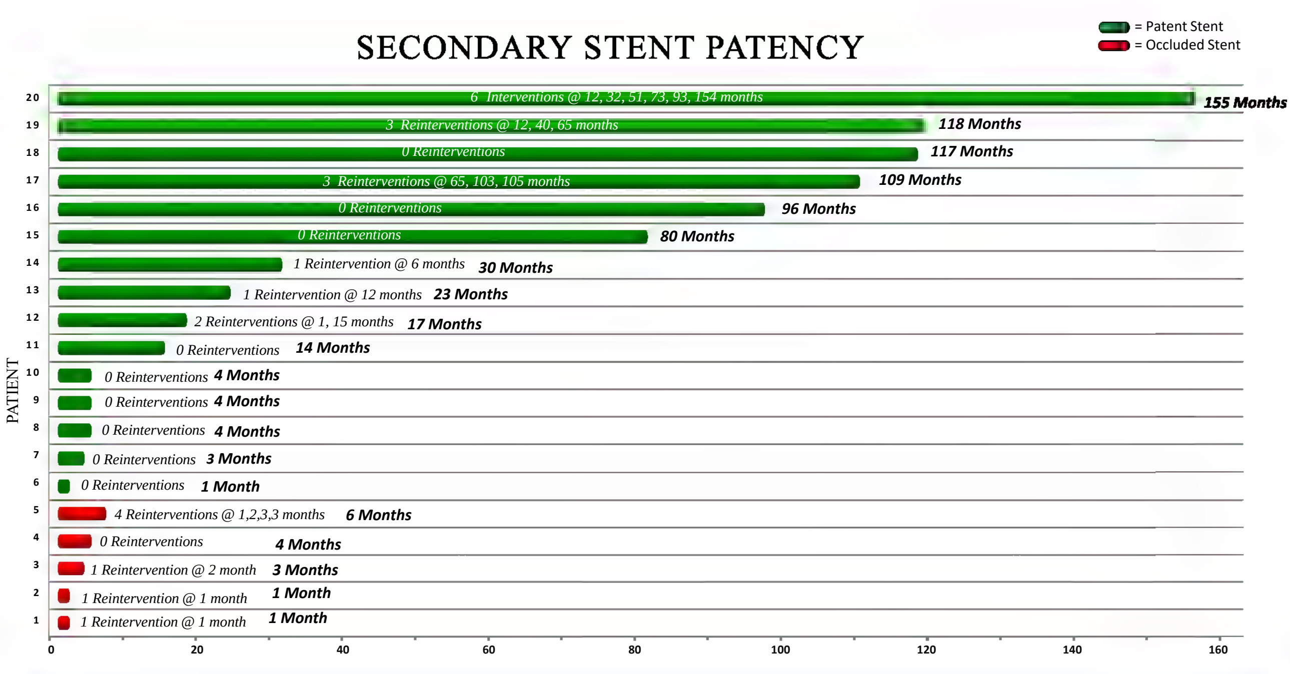

Fig 2. Bar graph of 20 limbs with stent extension into the profunda femoris vein. Secondary patency and reintervention detail are shown (see text).

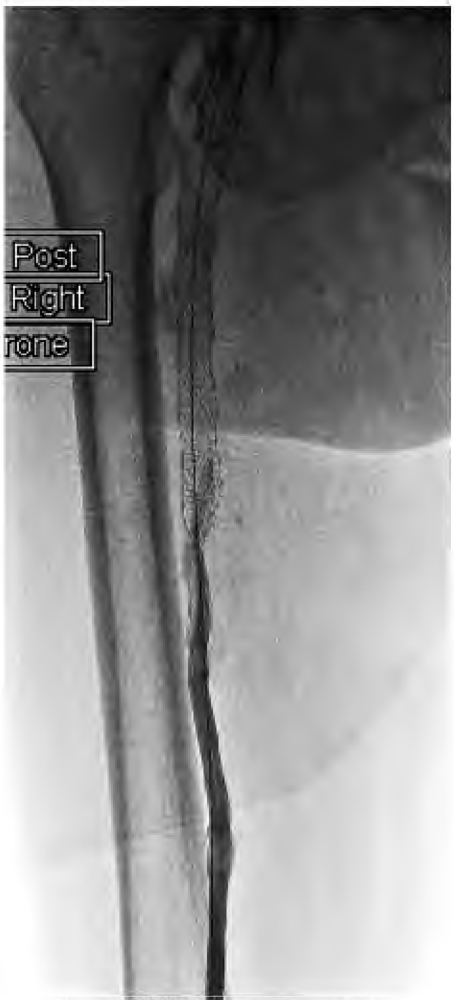

Fig 3. Extension of the iliac stent stack into the profunda femoris to the midfemoral level. This stent had remained patent up to the last follow-up, 1 year and 5 months after the procedure.

recurrent symptoms (Table) and 17 patients had been on chronic anticoagulation.

Stent extension into the profunda femoral vein was a salvage procedure after a prior stent procedure had failed (occluded) in 17 limbs. In three limbs, the deep femoral vein was primarily chosen during the initial iliac vein stent procedure as the better landing site than the common femoral vein. Occluded iliac vein stents were reopened by balloon maceration alone in 12 limbs and by pharmacomechanical lysis in 5 limbs.

There was no mortality (30 day), pulmonary embolus, or limb loss. No local or groin pain related to the profunda extension was noted in this series. The duration of occlusion or secondary patency and reintervention details is shown in Fig 2. Fifteen stents remained patent and five were occluded at maximum follow-up for each limb. Of the 20 limbs, (50%) 10 required reintervention. The reasons for reintervention was clearance of in-stent restenosis (44%), pharmacomechanical thrombectomy in a similar number (44%), and stent extension in the remainder (12%). Ten limbs (50%) required no reintervention, with all but one of these maintaining their patency during follow-up. The median duration of secondary patency in stents that remained patent was 23 months (range, 1-155 months). Of the 20 stents, (75%) 15 have remained patent at last follow-up (40% for ≥6 years).

The symptom status of all stented limbs at the end of the follow-up period is shown in Table. There was significant improvement in symptoms if stent patency was maintained.

DISCUSSION

Extension of the iliac vein stent into the profunda femoris is a salvage procedure representing less than 1% of stent implants in our institution. The common femoral vein is the preferred caudal landing site, even when the femoral trijunction seems to be diseased but not totally occluded. This usually works and overall stent occlusion is very rare (<3%).[3] Extension of the stent into the profunda femoris is usually considered only when the initial common femoral landing site fails. This was the case in 17 of the 20 limbs in the current series. The profunda femoris vein was primarily chosen as the landing site in 3 of the 20 limbs where profunda stenosis (Fig 1, *A*) at or near the confluence was apparent during the initial stenting procedure. Van Vuuren et al[4] used duplex to identify suitable landing zone for deep femoral extension of iliac vein stents in 14 limbs; short-term secondary patency of 92% was reported.

Long-term cumulative patency of stents extended into the profunda femoris is acceptable, considering that it is a salvage procedure in extreme clinical circumstances with few other options. The propensity of the smaller caliber profunda vein to support patency of a relative long stent stack over a number of years is impressive (Fig 3).

Inflow disease patterns at the femoral trijunction. Chronic total occlusion (CTO) of the common femoral vein occurs in continuity with iliac vein occlusion in an estimated 10% of CTO limbs. CTO of the common femoral vein segment in isolation is rare. However, nonocclusive stenosis of the common femoral vein occurs in approximately 70% of post-thrombotic iliac vein disease receiving stent treatment.[5] The disease in the common femoral vein can be usually covered by the stent by extending it to land just above the profunda femoris ostium (Supplementary Fig, online only). Extension of the stent into the profunda femoris vein is required only when the initial common femoral landing zone fails, resulting in stent occlusion or when stenosis or occlusion of the proximal profunda femoris vein stenosis below the confluence is obvious. Stenosis and CTO of the

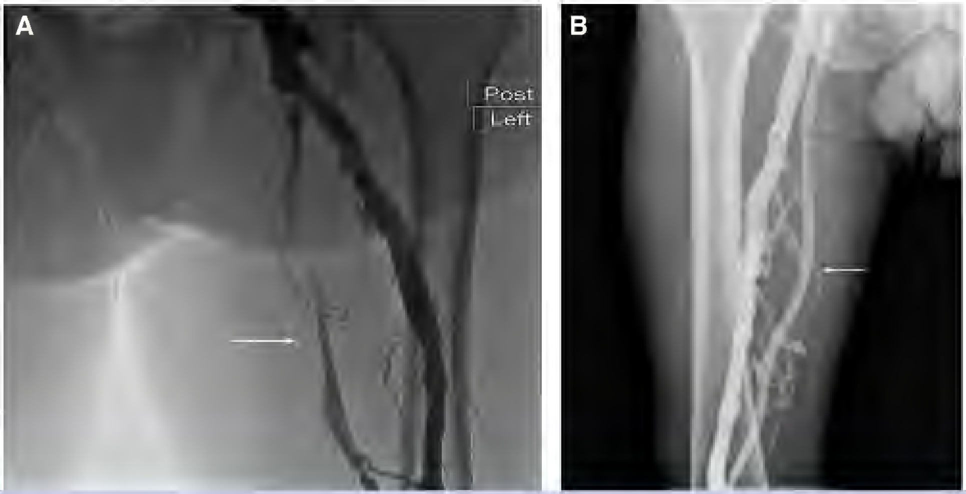

Fig 4. (A) Axially transformed profunda femoris vein. The native femoral vein is occluded with a post-thrombotic remnant (arrow). Because of its enlarged size very similar to the native femoral vein, the axially transformed profunda is frequently mistaken for it on venograms. On close inspection, the profunda femoris vein is seen to course near or over the femoral shaft. The native femoral vein typically is farther away from the femoral shaft in the upper and middle thigh. **(B)** Partial axial transformation of the profunda femoris vein. The native femoral vein (arrow) is diffusely stenotic likely from post thrombotic disease, as suggested by tributary collaterals and absent valves. Often the venogram is misinterpreted in such cases as congenital duplication of the femoral vein.

femoral vein occurs frequently, but can be ignored if the profunda femoris vein is open and provides adequate inflow via the common femoral vein into the stent. The profunda femoris vein is involved in post-thrombotic processes along with the femoral vein in an estimated 10% to 15% of limbs. A case-by-case judgement is required to determine if the profunda femoris disease precludes choosing the common femoral vein as the initial favored landing zone. The profunda femoris vein often enlarges when the femoral vein is stenotic or occluded (axial transformation). The common femoral vein is the preferred landing zone in these cases.

Fig 5. (A and **B)** The blind segment of common femoral vein (arrow) with occluded major tributaries (femoral and profunda femoris veins). Numerous smaller collaterals are seen to drain into the segment, resembling the serpent headed god from Greek mythology (**B**, right). Stents extended into the segment can remain patent (see text). **(B)** The image belongs to the Victoria & Albert Museum, London (Benvenuto Cellini, *Head of Medusa*, bronze, ca. 1545-50.).

Axial transformation. Among the lower limb veins, the deep femoral vein has several enigmatic features. Some of this is rooted in embryology. The deep femoral vein is the initial axial vein during early development. The femoral vein becomes the axial vein in later development as the deep femoral vein recedes in caliber and function. A high resistance profunda-popliteal connection seems to be retained in most limbs and the deep femoral vein does not completely disappear. In cases of femoral vein obstruction from thrombosis, flow is directed through the deep femoral vein, which then acts as a collateral. The deep femoral vein can be seen in venograms as early as only a few hours after femoral vein occlusion.[6] Unlike tributary collaterals (muscular veins), the deep femoral has valves that are oriented to aid collateral flow parallel to the femoral vein. Because of this, the deep femoral vein rapidly enlarges over the course of a few months to carry all the femoral flow replacing it functionally (axial transformation). This may explain the curious finding that most profunda stent extensions ultimately manage to maintain their secondary patency lasting many years, despite requiring one or more interval corrective reinterventions. The enlarged deep femoral vein is closer to the femoral shaft than the native femoral vein. This subtle difference is often missed on venograms, and the axially transformed deep femoral vein is mistaken for the native femoral vein (Fig 4, *A*). Partial axial transformation occurs as well, when a diffusely stenotic post-thrombotic femoral vein is seen with an enlarged deep femoral collateral (Fig 4, *B*). This configuration is often mislabeled as congenital duplication of the femoral vein. The saphenous vein is also a parallel collateral, but plays only a minor role in femoral vein occlusions.[7–10] This is because normal perforator valves prevent deep venous flow from entering the superficial venous system. Because of the major collateral role of the deep femoral vein, long-term sequelae from femoral vein thrombosis are rare. Most such cases can be treated conservatively with success.

Medusa collaterals. The femoral confluence is rich with many tributaries with collateral potential. These connect to the external iliac, obturator, common femoral, deep femoral, femoral, and saphenous veins. Interconnections between these branch tributaries often develop in chronic post-thrombotic limbs. Enlarged vasa vasorum can also be seen to carry collateral flow in chronic cases.

Occasionally, both femoral and deep femoral veins are occluded presenting a short patent stump of common femoral vein draining a number of small caliber collaterals resembling a Caput Medusa (Fig 5, *A* and *B*). Although the venographic appearance is daunting, it has been our experience that roughly one-half of the stents landed in this segment stay open, apparently because adequate inflow is recruited into the stent once the proximal obstruction is cleared. Prestent venograms underestimate inflow because the working sheath is obstructive, the viscosity of contrast (3×) does not opacify smaller caliber vessels or the contrast is injected against tributary valves (especially veins draining thigh muscles). It is our recommendation not to withhold a stent procedure in CTO of common femoral vein tributaries based on venographic prejudgment of inflow. If initial stenting fails, an endophlebectomy remains as a backup option.[11–13]

Similar comments apply regarding the practice of judging the adequacy of stent inflow by observing the speed of contrast clearance after the stent is in place. Many stents have remained patent despite poor contrast clearance at procedure completion. In some cases, asymmetrical dilatation of the vein may result in trapping of contrast between the stent and the vein wall falsely mimicking poor dye clearance.

Study limitations. This is a retrospective analysis of a small group of patients undergoing a rare procedure. No broadly applicable generalizations are possible from these results. Wall stents were exclusively used for in this series. We have no experience with the newer generation of venous stents for this application.

CONCLUSIONS

Extension of the iliac vein stent into the profunda femoris vein is an available option when the customary landing zone in the common femoral vein is not feasible owing to extensive post-thrombotic disease. This is a worthwhile salvage procedure with an acceptable long-term secondary patency, even though correctional reintervention is often required.

AUTHOR CONTRIBUTIONS

Conception and design: SR, TS, AJ
Analysis and interpretation: CL
Data collection: CL, TP
Writing the article: SR, CL, TP
Critical revision of the article: SR, TS, AJ
Final approval of the article: SR, CL, TP, TS, AJ
Statistical analysis: CL
Obtained funding: This work was self-funded
Overall responsibility: SR

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Supplementary Table (online only). Demographics

Characteristics	
Patients (limbs)	20 (20)
Median age, years (range)	46 (17-80)
Median BMI (range)	31 (22-62)
Laterality, L/R	14/6
Sex, male/female	6/14
PTS	17
NIVL	3
CEAP clinical class	**No.**
3	7
4	10
5	2
6	1

BMI, Body mass index; *NIVL*, nonthrombotic iliac vein lesion; *PTS*, post-thrombotic syndrome.

Supplementary Fig (online only). Iliac vein stent extension into the common femoral vein to cover post-thrombotic disease. The stent was extended to land just above the ostia of the femoral and profunda femoral veins (arrow). An internal jugular or contralateral femoral approach may yield more accurate placement of stents when deployed from the tip of the constraining sheath (see text).