Factors associated with difficulty in stenting the chronic iliofemoral venous obstruction

International Angiology 2023 August;42(4):337-43
DOI: 10.23736/S0392-9590.23.05001-0

ORIGINAL ARTICLE
VENOUS DISEASE

EDITOR'S CHOICE

Factors associated with difficulty in stenting the chronic iliofemoral venous obstruction

Moustafa ELFEKY [1], Mohammad E. BARBATI [1], Karina SCHLEIMER [1], Alexander GOMBERT [1], Long PIAO [1], Soroosh SHEKARCHIAN [2], Michael JACOBS [1, 2], Mahmood RAZAVI [3], Houman JALAIE [1, 2] *

[1]Department of Vascular and Endovascular Surgery, RWTH Aachen University Hospital, Aachen, Germany; [2]Department of Vascular Surgery, Maastricht University Medical Center, Maastricht, the Netherlands; [3]St. Joseph's Hospital, Orange, CA, USA

*Corresponding author: Houman Jalaie, Department of Vascular and Endovascular Surgery, RWTH Aachen University Hospital, Aachen, Germany. E-mail: hjalaie@ukaached.de

ABSTRACT

Background: The main aim of this article is to investigate the causes of technical failure during endovascular recanalization in patients with post-thrombotic syndrome with occluded iliofemoral veins and to suggest alternative techniques to improve outcomes in such challenging cases.

Methods: Between November 2015 and August 2020, 230 patients (274 limbs) treated in our institution with symptomatic chronic iliofemoral venous obstruction underwent endovascular recanalization with angioplasty and stent placement. Overall, the initial attempt was unsuccessful in 15 limbs. We retrospectively analyzed the basic demographic and health characteristics of the involved patients and evaluated the endovascular procedures and techniques that resulted in a successful second intervention.

Results: The first attempts at endovascular intervention were unsuccessful in 15 of the 274 limbs (5.4%). Failures were attributed to hostile groin areas in intravenous drug abusers caused by multiple punctures in six cases. In addition, five interventions failed due to prior surgery at the site of venous occlusion and in retroperitoneal space, three patients due to severe stent deformity, and one patient due to congenital venous aplasia. Of the 15 patients, 11 underwent a subsequent attempt that included six successful recanalizations. The mean follow-up time of the six patients with successful recanalization was 27 months (5-62 months). The primary, assisted primary and secondary patency rates were 83.3%, 100%, and 100%, respectively. The remaining five patients, in whom the second recanalization attempt failed, received conservative treatment.

Conclusions: Recanalization failure is rare in chronic venous obstruction patients. Severe stent deformities have the lowest chance of successful second intervention. Patients with a hostile groin or prior open surgeries at the occlusion site may be considered for reintervention with a success rate of nearly 50%.

(*Cite this article as:* Elfeky M, Barbati ME, Schleimer K, Gombert A, Piao L, Shekarchian S, *et al*. Factors associated with difficulty in stenting the chronic iliofemoral venous obstruction. Int Angiol 2023;42:337-43. DOI: 10.23736/S0392-9590.23.05001-0)

Key words: Postthrombotic syndrome; Venous thrombosis; Stents.

Post-thrombotic syndrome (PTS) is a medical condition that involves symptoms and signs of chronic venous obstruction (CVO) and/or deep venous reflux that develops following deep venous thrombosis (DVT).[1, 2]

Although PTS is not a life-threatening disease, it negatively impacts the quality of life (QOL). The poor self-reported physical QOL scoring in patients with PTS is comparable to that of patients with chronic diseases such as diabetes and congestive heart failure.[3] Treatment strategies for PTS are highly patient specific and may involve a combination of different modalities, including venous intervention and conservative therapy.

Endovascular venous recanalization is preferred to open surgical procedures for CVOs with high technical success rates of up to 93% with favorable short- and long-term patency.[4-8]

A review of the published literature revealed scarce data on the causes of technical failure during venous recanalization in patients with CVO, as well as ways to intervene when the first attempt fails.

According to Hartung *et al.*, factors such as ipsilateral deep venous surgery at the side of venous occlusion, lesions located on the right side, number of occluded venous segments, and involvement of the common femoral vein (CFV) affect the feasibility of recanalization.[5]

The purpose of this study was to investigate the factors affecting the technical success rate of recanalization on the first attempt and to suggest strategies to overcome failure in challenging cases.

Materials and methods

The study followed the principles of the Declaration of Helsinki, and a waiver of informed consent was granted by the institutional review board because of the retrospective nature of the study.

Patients

Between November 2015 and August 2020, 230 patients treated in our institution (274 limbs) with symptomatic CVO underwent endovascular venous recanalization and stent placement. Intervention was unsuccessful in 15 limbs (5.4%). We obtained information on the basic demographic and health characteristics of unsuccessful cases, as well as details of the endovascular procedure, including the failure point of recanalization, techniques to overcome it, and implanted stents.

Endovascular intervention

All procedures were performed by one of the two board-certified vascular and endovascular surgeons. The procedures were performed in the supine position, under general anesthesia.

All patients received an initial dose of 5000 IU of intravenous heparin after successful ultrasound-guided puncture of the access vein. Therapeutic anticoagulation with unfractionated heparin was maintained with a target activated clotting time >200 s.

The primary access site of intervention was usually the ipsilateral femoral vein at the level of the midthigh. In cases with total occlusion of the femoral vein in which a puncture was impossible, a distal puncture of the popliteal vein was performed with subsequent recanalization of the femoro-iliac lesion.

By puncturing the femoral vein, shorter guidewires and catheters could be used with greater pushability and torquability compared to that offered by the popliteal access. The point of entry was chosen at a sufficient distance caudal to the ostium of the deep femoral vein to allow stenting of the CFV, if necessary. Subsequently, initial venography was performed to evaluate the extension of the pathology and mark the occluded segment.

When antegrade approach using various wires and catheters was unsuccessful, a retrograde approach through the right internal jugular vein was attempted. Recanalization was aborted if the procedure time exceeded three hours or if contrast extravasation occurred, impairing visualization. The patients were then rescheduled for a second attempt.

In the second attempt, to decrease the radiation exposure, contrast amount, and operation time, preoperative analysis of the first venography images was performed to identify the non-recanalized segment from the first attempt. The right jugular and ipsilateral femoral veins were simultaneously accessed from the beginning of the procedure.

A sharp recanalization technique was used upon reaching the previous "failure point" to traverse that segment. This technique entailed the use of the sharp end of a 0.018-inch Terumo Glidewire (Terumo, Tokyo, Japan). With the help of a needle holder, the guidewire was pushed using multiple repetitive high velocity strokes to traverse the occlusion site. The position of the wire was ensured using multiplane fluoroscopy before initiating the sharp recanalization.

If antegrade passage through the occlusion failed, a balloon (10-14 mm diameter, based on the diameter of the vein) was introduced through the jugular venous access and inflated just above the occluded segment. Correct alignment between the wire and balloon was ensured using multiplane fluoroscopy (Figure 1). The sharp recanalization technique was then performed using the inflated bal-

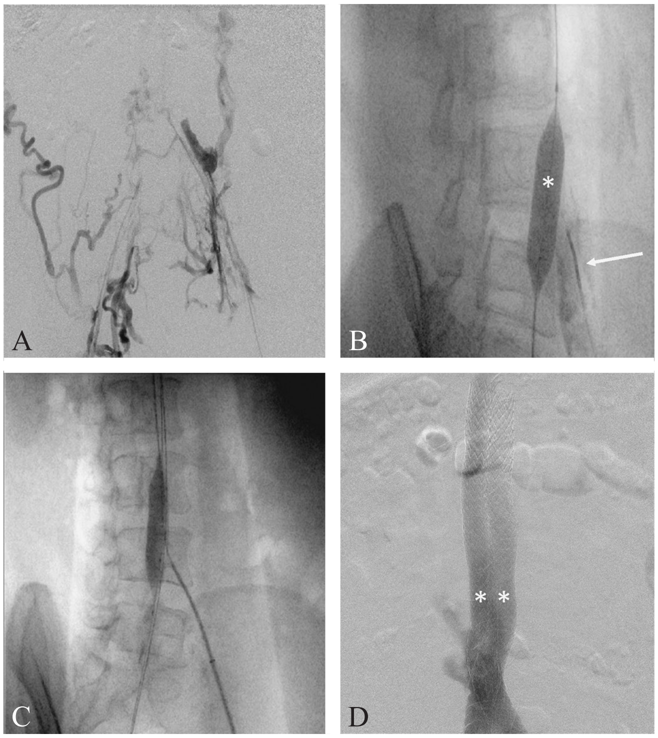

Figure 1.—Intraoperative images demonstrating the sharp recanalization of left common iliac vein at the level of iliocaval confluence: A) chronic bilateral iliofemoral and inferior vena cava occlusion with extensive collaterals; B) lateral view showing inflated balloon (*) in inferior vena cava going into the right common iliac vein. The balloon is introduced from the jugular access. Positioning the vertebral catheter (arrow) in the left common iliac vein, as near as possible to the balloon; C) anteroposterior view showing the successful perforation of the balloon from the left side with the back of a 0.018” Terumo Glidewire; D) final phlebography after stent implantation in inferior vena cava (**) into both iliac veins in double barrel technique.

loon as target, while aiming to puncture it with the guidewire. If the puncturing of the balloon was unsuccessful due to instability of the antegrade wire, a 4-8 mm balloon was introduced over the inverted antegrade guidewire and placed as close as possible to the point of interest (Figure 2). This provided more stability to the wire and helped open a new channel for the guidewire to pass through. Moreover, it ensured a centralized wire position within the vessel lumen and reduces the risk of extravasation.

An alternative technique could be applied in which two balloons were introduced and inflated from the retrograde and antegrade access placed as close as possible to stenotic lesion (Figure 3). This could facilitate the advancement of the wire by creating a channel within the trabeculation at this area.

After the successful puncture of the balloon, a low-profile catheter was passed through the recanalized segment, and the reversed 0.018” Terumo guidewire was replaced with a new 0.035” Terumo guidewire and placed in the healthy segment of the inferior vena cava. Predilatation up to the diameter of the targeted vein segment was performed. If passage of the intended initial balloon (12, 14, or 16 mm) was not possible, serial dilation using smaller balloons (4 mm) was attempted. When unsuccessful, a loop snare was introduced from jugular access and a through and through wire access was established to improve crossing ability of the balloon. After successful predilatation, the guidewire was changed to an Amplatz® Super Stiff Guidewire (Boston Scientific, Marlborough, Ma, USA) for the rest of the procedure.

An intraluminal assessment was then performed using

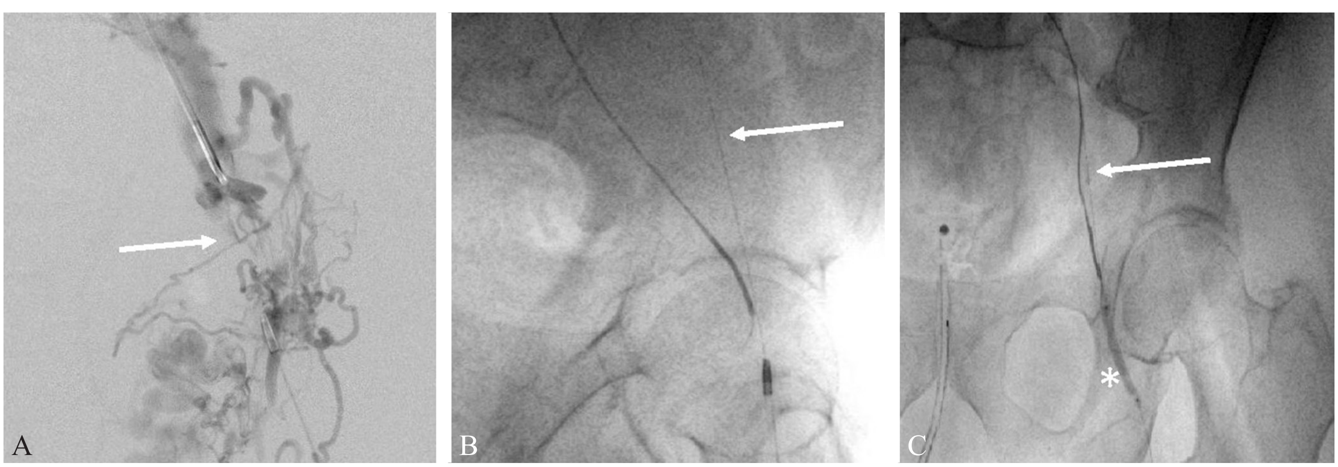

Figure 2.—A) Stenotic lesion at the left common femoral vein (arrow); B) first attempts of sharp recanalization with the back of a 0.018” Terumo Glidewire were unsuccessful (the arrow shows extravenous position of the wire); C) 4-mm balloon (*) introduced over the inverted antegrade guidewire from femoral access to ensure a centralized position of wire during the sharp recanalization (arrow).

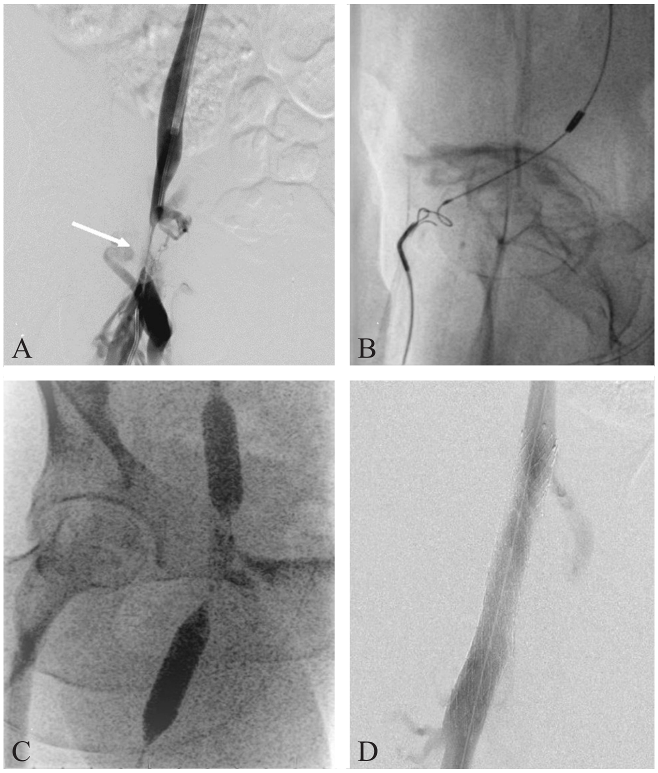

Figure 3.—A) Stenotic lesion at the level of right common femoral vein; B) lateral view shows failure of recanalization from the antegrade and retrograde access; C) pre-and post-stenotic balloon dilatation helping in opening new intraluminal channel and disturbing the trabeculation at the stenotic lesion as well as ensuring a centralized position of wires during the sharp recanalization; D) phlebography after successful recanalization and stent implantation.

intravascular ultrasound (IVUS) to confirm the extent of the pathology and determine the exact location of the distal and proximal stent landing zones. The next steps of the procedure, including stent implantation, post-dilatation, completion angiogram, and IVUS evaluation, as well as postoperative care and follow-up, have previously been described.[4]

Results

Among the 15 subjects, the clinical part of Clinical-Etiology-Anatomy-Pathophysiology classification score was C3 in four (27%), C4 in six (40%), and C6 in five (33%) patients (Table I). Hostile groin due to repeated multiple punctures was the most common reason that led to venous occlusion (N.=6, 40%), followed by previous surgery (N.=5, 33%); Two patients had an open venous thrombectomy with creation of an AV fistula due to iliofemoral DVT four years prior to admission in our institution. One patient underwent open repair of the iliac vein during nephrectomy 7 years before deep venous occlusion, another patient underwent open iliac vein repair with patchplasty during closure of an aortic septal defect in childhood. One patient had a surgical resection of inguinal mass and lymph nodes three years before being referred to our center (Figure 4). The lesions that contributed to failure of recanalization were anatomically located in the CFV in ten (66%) limbs and the caudal part of the external iliac vein (EIV) in five (33%) limbs (Table II).

Four patients were not scheduled for a second attempt

Table I.—*Demographics of included patients.*

Demographics	Total (N.=15)	Successful in 2nd try (N.=6)	Unsuccessful (N.=5) or not planned for 2nd try (N.=4)
Age	44±11	51±9	39±10
Gender			
Female	8 (53%)	2 (25%)	6 (75%)
Male	7 (47%)	4 (57%)	3 (43%)
BMI, kg/m^2	28±7	28±4	29±8
Past medical history			
DVT	15 (100%)	6 (40%)	9 (60%)
Previous surgery at the site of venous occlusion	5 (33%)	2 (40%)	3 (60%)
Chronic stent occlusion due to stent deformity	3 (20%)	0 (0%)	3 (100%)
History of IV drug abuse	6 (40%)	4 (67%)	2 (33%)
Venous aplasia	1 (7%)	0 (0%)	1 (100%)
Highest C of CEAP			
C3	4 (27%)	3 (20%)	1 (7%)
C4	6 (40%)	4 (27%)	2 (13%)
C6	5 (33%)	3 (20%)	2 (13%)
Venous claudication	9 (60%)	5 (55%)	4 (45%)

DVT: deep vein thrombosis; IV: intravenous; CEAP: classification of the severity of varicose veins.

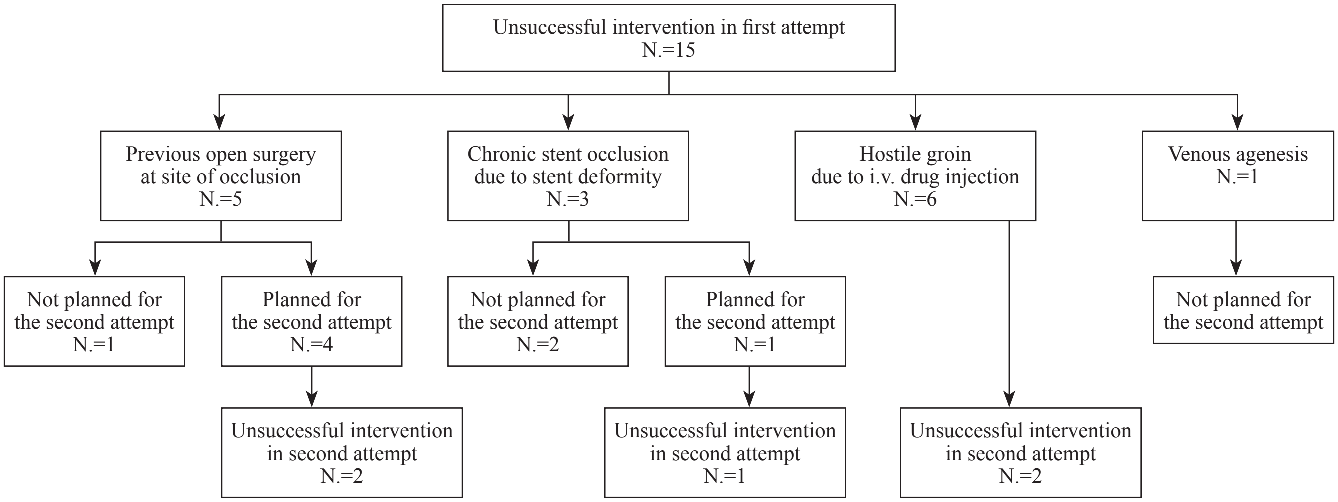

Figure 4.—Diagram showing the patients with unsuccessful recanalization in the first attempt.

Table II.—*Distribution of post thrombotic changes and point of failure.*

#	Iliac vein	Common femoral vein	Femoral vein	Deep femoral vein	Point of failure	Second attempt	Side of lesion
	Involved/not involved	Involved/not involved	Involved/not involved	Involved/not involved		Successful/ unsuccessful / not performed	
1	-	+	-	-	CFV	Successful	Right
2	+	+	-	-	CFV	Successful	Left
3	+	+	-	-	CFV	Successful	Right
4	+	+	-	-	EIV	Successful	Right
5	+	+	-	-	CFV	Successful	Right
6	+	+	+	-	CFV	Successful	Left
7	-	+	-	-	CFV	Unsuccessful	Left
8	-	+	+		CFV	Unsuccessful	Left
9	+	-	-	-	EIV	not performed	Right
10	+	-	-	-	EIV	not performed	Left
11	+	+	-	-	CFV	Unsuccessful	Right
12	+	+	-	-	CFV	Unsuccessful	Left
13	-	+	-	-	CFV	not performed	Left
14	+	+	-	-	EIV	not performed	Left
15	+	+	-	-	EIV	Unsuccessful	Right

CFV: common femoral vein; EIV: external iliac vein.

and were prescribed conservative treatment indefinitely. Two of them had severe stent deformities from previous stenting and were not planned for re-intervention. One patient had a prior surgery at groin who we decided not to proceed for the second attempt. Another patient was not planned for the re-intervention due to aplasia of the left external iliac vein.

Eleven patients were rescheduled for a second intervention, of which six had successful recanalization. Of the five patients in whom the second attempt failed, include one patient with chronic occlusion due to stent deformity caused by maldeployment (Figure 5), previous surgery; N.=2, intravenous drug abuser; N.=2). In all patients, the treated obstructed venous segments were in the CFV and common iliac vein. Data on the implanted stents are presented in Table III.

The mean follow-up time for the 6 patients with successful recanalization was 27 months (range: 5-62 months). The symptoms and signs were alleviated in all patients after successful endovascular treatment. In three patients, venous ulcers healed without recurrence. Venous claudication disappeared in all six patients with success-

Figure 5.—Deformed distal stent-struts.

Table III.—*Treatment aspects.*

#	Treated segments	Stent description
1	EIV + CFV	Abre 14x100 mm
2	EIV + CFV	Venovo 14x100 mm
3	EIV + CFV	Sinus Venous 14x100 mm
4	EIV + CFV	Sinus Venous 14x100 mm
5	EIV + CFV	Abre 14x120 mm
6	EIV + CFV	Abre 14x120 mm

CFV: common femoral vein; EIV: external iliac vein.

Table IV.—*Follow-up data.*

Parameters	Value
Mean duration of follow-up, months (range)	27 (5-62)
Primary patency rate	83.3%
Assisted primary patency rate	100%
Secondary patency rate	100%
Mean reduction of highest C of CEAP (range)	2.6 (0-5)
Venous claudication	0%

ful intervention. Intraluminal narrowing of the stents was observed in one patient with recurrence of symptoms.

The primary, assisted primary and secondary patency rates were 83.3%, 100%, and 100%, respectively (Table IV).

Discussion

This analysis confirms that the technical failure rate of recanalization in patients with chronic iliofemoral venous occlusions is low. In the current study, endovascular recanalization of CVO was unsuccessful on the first attempt in only 15 limbs (5.4% of total limbs). Eleven of those patients were rescheduled for a second procedure, of which six interventions (40%) were successful yielding good clinical outcome.

The technical failure rate was observed in our cohort when the CFV was occluded, irrespective of the side of occlusion or the number of segments occluded (Table II).

In the current study, six patients (40%) presented with hostile groin after repeated intravenous drug injections. Repeated injections increase the risk of infection, arterial and venous injuries, and CVO.[9] The authors have proposed several mechanisms for this phenomenon, including an increased tendency for coagulation, valvular damage caused by anoxia, and stasis.[10] Most authors suggest that it is the repeated puncture of the vein, consequently leading to endothelial damage and release of tissue factors that is responsible for DVT. Moreover, the coincidental infection and superficial thrombophlebitis further attenuate this risk.[10] Interventional treatment of CVO is especially challenging in these patients because of the presence of sinuses and infections that create a hostile groin environment.

The other common factor leading to technical failure in our cohort was previous surgery at the site of venous occlusion (N.=5), which corresponds with other reports in the literature. The development of postoperative DVT may pose serious risk of complications to patients who have recently undergone surgery.[11] In addition, direct damage to the vessel walls during major open surgery is thought to be one factor that also explains the higher proportion of proximal DVT.[12, 13]

Severe stent deformation was another cause of technical failure. In a study reporting the long-term outcome of stenting after catheter directed lysis in patients with DVT, the rate of stent deformity was 11%.[14] The incidence of stent deformities and their long-term consequences after stenting in CVO have not yet been thoroughly investigated. In patients with CVO due to stent fractures, relining with stent extension may be necessary to restore the venous flow.[15] Recanalization of chronic in-stent occlusion due to severe stent deformity could be a greater challenge with a lower success rate. Dislocated stent segments or severe deformity of the stent structure with collapsing struts can block the passage of even small guidewires.

One of the associated rare syndromes is the Klippel-Trenaunay Syndrome (KTS) which may also contribute to failure of recanalization. Servelle *et al.* reported 786 cases of KTS with agenesis of a segment of the deep veins that resulted in DVT.[16] In the current cohort, one female patient had KTS, where the recanalization procedure was unsuccessful due to the aplasia of the EIV.

According to the literature review, no specific technique is recommended for the treatment of the previously mentioned factors. However, as per our analysis, few techniques could be highly effective in the event of recanalization failure, such as the sharp recanalization which has been described in several studies.[17]

An alternative technique involves inflating two balloons distal and proximal to the occlusion point. This interrupts the intraluminal trabeculation and thereby creates an entry point for the guidewire, and standard or sharp recanalization can subsequently be used to continue the recanalization.

To reduce the risk of technical failure during endovascular attempts in patients with CVO, it is necessary to recognize the causes of occlusion, ensure careful preoperative planning, and continue to develop new techniques.

Limitations of the study

This study has several limitations, including its retrospective design and small number of patients. However, this study is the first to describe in detail the factors that contribute to the failure of endovascular venous intervention even after multiple attempts and provide suggestions for reducing the risk of recanalization failure.

Conclusions

The technical failure rate of recanalization in patients with CVO is low. Occlusions due to severe stent deformities have probably the least chance of successful second intervention. Patients with a hostile groin caused by multiple intravenous injections and those with previous open surgeries at the site of venous occlusion could be considered for reintervention with almost 50% success rate.

References

1. Baldwin MJ, Moore HM, Rudarakanchana N, Gohel M, Davies AH. Post-thrombotic syndrome: a clinical review. J Thromb Haemost 2013;11:795–805.

2. Kahn SR, Partsch H, Vedantham S, Prandoni P, Kearon C; Subcommittee on Control of Anticoagulation of the Scientific and Standardization Committee of the International Society on Thrombosis and Haemostasis. Definition of post-thrombotic syndrome of the leg for use in clinical investigations: a recommendation for standardization. J Thromb Haemost 2009;7:879–83.

3. Kahn SR, Shbaklo H, Lamping DL, Holcroft CA, Shrier I, Miron MJ, *et al.* Determinants of health-related quality of life during the 2 years following deep vein thrombosis. J Thromb Haemost 2008;6:1105–12.

4. Barbati ME, Gombert A, Toonder IM, Schleimer K, Kotelis D, de Graaf R, *et al.* Iliocaval Skip Stent Reconstruction Technique for Chronic Bilateral Iliocaval Venous Occlusion. J Vasc Interv Radiol 2020;31:2060–5.

5. Hartung O. Results of stenting for postthrombotic venous obstructive lesions. Perspect Vasc Surg 2011;23:255–60.

6. Hölper P, Kotelis D, Attigah N, Hyhlik-Dürr A, Böckler D. Long-term results after surgical thrombectomy and simultaneous stenting for symptomatic iliofemoral venous thrombosis. Eur J Vasc Endovasc Surg 2010;39:349–55.

7. Raju S, Darcey R, Neglén P. Unexpected major role for venous stenting in deep reflux disease. J Vasc Surg 2010;51:401–8, discussion 408.

8. Neglén P. Chronic venous obstruction: diagnostic considerations and therapeutic role of percutaneous iliac stenting. Vascular 2007;15:273–80.

9. Ge BH, Copelan A, Scola D, Watts MM. Iatrogenic percutaneous vascular injuries: clinical presentation, imaging, and management. Semin Intervent Radiol 2015;32:108–22.

10. Jain N, Avanthika C, Singh A, Jhaveri S, De la Hoz I, Hassen G, *et al.* Deep Vein Thrombosis in Intravenous Drug Users: An Invisible Global Health Burden. Cureus 2021;13:e18457.

11. Ellis MH, Elis A. Perioperative venous thromboembolism prophylaxis in Israel: a survey of academic surgical departments. Eur J Haematol 2004;73:104–8.

12. Lee SY, Ro H, Chung CY, Lee KM, Kwon SS, Sung KH, *et al.* Incidence of deep vein thrombosis after major lower limb orthopedic surgery: analysis of a nationwide claim registry. Yonsei Med J 2015;56:139–45.

13. Anderson FA Jr, Wheeler HB. Venous thromboembolism. Risk factors and prophylaxis. Clin Chest Med 1995;16:235–51.

14. Foegh P, Strandberg C, Joergensen S, Myschetzky PS, Klitfod L, Just S, *et al.* Long-term integrity of 53 iliac vein stents after catheter-directed thrombolysis. Acta Radiol 2023;64:881–6.

15. Black S, Gwozdz A, Karunanithy N, Silickas J, Breen K, Hunt B, *et al.* Two Year Outcome After Chronic Iliac Vein Occlusion Recanalisation Using the Vici Venous Stent®. Eur J Vasc Endovasc Surg 2018;56:710–8.

16. Servelle M. Klippel and Trénaunay's syndrome. 768 operated cases. Ann Surg 1985;201:365–73.

17. Cohen EI, Beck C, Garcia J, Muller R, Bang HJ, Horton KM, *et al.* Success Rate and Complications of Sharp Recanalization for Treatment of Central Venous Occlusions. Cardiovasc Intervent Radiol 2018;41:73–9.

Conflicts of interest
The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Authors' contributions
Moustafa Elfeky: preparation study conception and design, interpretation of results, manuscript drafting. Mohammad E. Barbati: data collection, statistical analysis, critical revision. Karina Schleimer, Alexander Gombert, and Michael Jacobs: critical revision. Long Piao: data collection, statistical analysis. Soroosh Shekarchian: statistical analysis, critical revision. Mahmood Razavi: critical revision, data analysis assistance. Houman Jalaie: preparation study conception and design, interpretation of results, editing the manuscript, critical revision. All authors reviewed the results and approved the final version of the manuscript.

History
Article first published online: May 31, 2023. - Manuscript accepted: May 3, 2023. - Manuscript revised: April 18, 2023. - Manuscript received: November 16, 2022.