Recent Developments in the Management of the Post-Thrombotic Leg and Venous Compression Syndromes

Trombotik Bacak ve Venöz Kompresyon Sendromlarının Tedavisinde Yeni Gelişmeler

**ABSTRACT** Interest in and use of minimally invasive treatments in both acute and chronic deep venous pathologies is currently increasing exponentially. In cases of post-thrombotic syndrome with objective (on imaging) vein aberrations after deep vein thrombosis (DVT), endovenous percutaneous transluminal angioplasty and stenting have shown good clinical success rates with relatively high patency and low morbidity and mortality rates. Furthermore, additional interventions, such as endophlebectomy and arteriovenous fistula creation, are might be needed in case of common femoral vein involvement. In cases of venous compression syndromes without a history of DVT, even better results are obtained. This new field currently shows many interesting developments, with materials specifically designed for the deep venous system becoming available.

**Key Words:** Post-thrombotic syndrome; stents; venous thrombosis; cardiovascular diseases; magnetic resonance imaging; phlebography; venous thromboembolism

**ÖZET** Günümüzde hem akut hem de kronik derin patolojilerde minimal invaziv tedavilerin kullanıma katlanarak artmaktadır. Derin ven trombozundan (DVT) sonra objektif (görüntülemede) ven aberasyonları olan post-trombotik sendrom olgularında, endovenöz pekütan luminal anjiyoplasti ve stentleme göreceli olarak yüksek açıklık ve düşük morbidite ve mortalite oranları ile iyi klinik başarı oranları göstermektedir. Ayrıca, common femoral ven tutulumu varsa, endoflebektoni ve arteriovenöz fistül oluşturulması gibi ek girişimler de gerekebilir. DVT hikayesi olmayan venöz kompresyon sendromu olgularında daha iyi sonuçlar elde edilmiştir. Bu yeni alan günümüze, derin venöz sistem için özel olarak tasarlanmış materyaller kullanıma hâzırlandıkça, birçok ilginç gelişme göstermektedir.

**Anahtar Kelimeler:** Posttrombotik sendrom; stentler; venöz tromboz; kalp ve damar hastalıkları; manyetik rezonans görüntüleme; flebografi; venöz thromboembolizm

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Recent insights into the management of the post-thrombotic syndrome (PTS) and other venous outflow pathologies have led to worldwide use of endovascular techniques in these disorders. PTS is a relative frequently occurring disease following acute deep venous thrombosis (DVT), most frequently of the lower extremity. DVT itself has an incidence of 1-2 per 1000 individuals annually. PTS develops in 20-50% of these. The most important risk factors for PTS development in DVT patients are recurrent ipsilateral thrombosis, residual obstruction or reflux after the DVT, proximal location of the thrombosis (especially at the level of
In our clinic, acting as a national referral center, all patient suspected of chronic deep vein obstruction receive a standardized diagnostic workup consisting of; a duplex ultrasound examination (DUS), a magnetic resonance venography (MRV),39,40 air plethysmography (APG)41 and a standardized intake (including CEAP,3 VCSS4 and Villalta5 scoring). Baseline and control DUS are performed in all cases by the same experienced vascular technician. The caval vein and iliac veins are scanned with the patient in a supine position and the degree of obstruction (if any) is noted and the diameter of the left iliac vein is assessed at the level of the crossing of the right iliac artery to diagnose May-Thurner syndrome (Figure 1). Afterwards, the patient is asked to stand up and obstruction and reflux in the deep venous system is assessed from the common femoral vein to the tibial veins. MRV examination is performed with when the patient in supine position with a dedicated 12-element phased-array peripheral vascular coil. 10mTen millilitersL of gadofosveset trisodium, given intravenously as a single dose is used as a contrast agent. This is a blood pool agent, which remains in the vascular system relatively long, to realize long scanning times. The entire inferior vena cava and bilateral venous tract, until at least the level of the infragenual
popliteal veins, is included in the MRV scanning. APG is used to assess hemodynamic abnormalities before PTA and stenting, and control APG’s are used to note any improvement in hemodynamic parameters. The APG system encompasses an air filled PTFE cuff placed around the lower leg of the patient connected to a pressure sensor, a computer translates the pressure changes within the cuff into volume changes in the lower leg. A number of quantitative hemodynamic parameters can be investigated by using APG, including: the degree of outflow, degree of venous backflow and the effectiveness of the calf-muscle pump. Clinical scoring systems are used in all patients for standardization and research purposes, and we highly encourage the creation of (inter)national registries for any type of new venous intervention. It is of note that the use of intravascular ultrasound (IVUS) to assess extend and degree of obstruction has been propagated in much of the research about venous stenting. IVUS has shown to be superior in the diagnostic process of obstructive venous disease, especially compared to single plane venography. In our experience however a combination of pre-operative MRV and peri-operative multiplanar venography and cone-beam CT are more than adequate to diagnose venous obstructive disease, plan and evaluate the intervention.

PTA AND STENTING PROCEDURE

After preoperative planning based on MRV and DUS findings, patients are admitted to our hospital for the recanalization procedure, which is performed under local analgesia in some cases of sole extraluminal vein compression (i.e. MTS) or general anesthesia in most cases of post-thrombotic disease or external compression syndromes. In cases of extensive obstruction in the common femoral vein, insufficient inflow into iliac segments can be expected; in these cases we perform an endophlebectomy of the CFV with or without an AV-fistula to improve patency during follow-up. The stenting procedure itself encompasses the cannulation of either the popliteal or the femoral vein under DUS guidance. A 5F sheath is then introduced and an antegrade venogram is made to assess extend and localization of the venous obstruction (Figure 2). By use of various stiff guide wires the obstruction is then passed, this might be technically difficult in cases of extensive post-thrombotic disease; however in our experience it is possible in almost all ca-

![FIGURE 1: May-Thurner syndrome as imaged on 3D-venography reconstruction in a frontal, axial and lateral view.](image1)

![FIGURE 2: Bilateral post-thrombotic obstruction in the right (A), left (B) and inferior caval vein (C).](image2)
ses (>95%). Following the crossing of the obstruction, the affected vein segments are pre-dilated with 8-14 x 40 mm balloon catheters. One or more self-expendable stents are then placed over the affected segments. Stent sizing is based on the diameter of the vessel and we oversize the stents by approximately 20% to prevent stent migration. Following stent placement the treated segments are dilated again by balloon angioplasty. The final control venography is then performed (Figures 3 and 4). In case of a successful procedure one expects to see contrast outflow through the stented segment and no contrast filling the collaterals. Post-operatively patients are anticoagulated for a period of at least 5 days with LMWH’s, during which anticoagulation with vitamin K antagonist is started. This is continued for at least 6 months, aiming at an INR of 2.5-3.5. Recently we have started using the new oral anticoagulants, i.e. Rivaroxaban and Dabigatran, in some patients instead of coumarines. Patients are generally discharged within 48 hours after intervention, and visit our outpatient clinic at regular intervals.

| ENDOPHLEBECTOMY AND ARTERIOVENOUS FISTULA CREATION |

The endophlebectomy is performed in patients in whom the future inflow, after stent placement, is predicted to be too low to guarantee long-term patency. This is done by careful examination of duplex, MRV and venography findings in a multidisciplinary team. The goal is to create one major lumen in a vein who’s lumen is generally divided into multiple smaller lumens by the intravascular webs and trabeculae. Via an incision in the patients groin the diseased common femoral vein is carefully exposed. A longitudinal venectomy is performed. Flow from the iliofemoral tract proximally and distally from the venectomy is controlled as well as from the major side branches. Any fibrotic residue is meticulously removed from the lumen. Care must be taken to leave an adequate vein wall. Afterwards the venectomy is closed either primarily or with a patch.

Arteriovenous fistula a generally created in the same session as the endophlebectomy is performed. In our experience, the use of a small polytetrafluoroethylene (PTFE) loop between the common femoral vein and artery is superior to direct site-to-site fistula or the use of a native vessel. One of the most important considerations for this is the fact that these fistulas can be easily occluded by use of endovascular techniques.

| TECHNICAL RESULTS AND CLINICAL OUTCOME |

Technical success rates of deep venous PTA and stenting described in literature are well above 90%, generally approaching 100 percent% depending on studies and patient population. In our own experi-
ence patency rates are 74%, 81% and 96% respectively, for primary, assisted primary and secondary patency rates, in a population with 14% primary and 86% secondary deep venous obstructions (N=63). Neglén et al. showed a clear difference between primary and secondary disease; 79% primary and 100% secondary patency in primary disease (N=518), and 57% primary and 86% secondary patency in secondary disease (N=464). Ulcer healing rate was circa 60% in Neglén’s combined population and ulcer recurrence rate was 8%. Other authors have reported on similar patency and ulcer healing rates.

## COMPLICATIONS

Theoretically the most feared complication of this type of intervention would be a (fatal) pulmonary embolism. In our experience and available articles this however has never occurred, and deep venous recanalisation can be considered a relatively safe procedure. The most important complication in these patients is the occlusion of the stented tract by thrombus. Therefore it is of the utmost importance to adequately anticoagulate these patients perioperatively by use of heparin or heparin-like substances. In our experience, 4% of treated patients developed an immediate re-occlusion during the procedure, which was immediately treated. Moreover, 11% developed re-occlusion the day after treatment, these were treated with catheter-directed thrombolysis, secondary PTA and stenting, surgical thrombectomy and arteriovenous fistula creation. Other procedure-related complications included mostly minor hemorrhages at the puncture site (10%). Post-procedure patients receive a standard regimen of LMWH’s low molecular weight heparins for a number of days, during which vitamin K antagonist treatment is started and continued for at least 6 months in our center (the method and length of anticoagulation post-stenting however is an issue currently under debate).

## NEW DEVELOPMENTS

It is of note that in current literature on stenting techniques rely on arterial stents placed in the venous system. Ideally however, venous stents are characterized by a higher flexibility and radial force. In many articles, stenting is performed by use of braided stainless steel stents, like the Wall stent (Boston Scientific, Galway, Ireland). By nature of their design these stents have a relatively high tendency to increase in diameter and shorten, and thereby showing tapering at the end. Moreover these stents are somewhat rigid, which can be viewed as suboptimal in a delicate system like the venous tract. We therefore preferred use of nitinol stents with great diameters. In our earlier experience, this included the Sinus XL stent (Optimed, Ettlingen, Germany), a stent with high radial force and adequate diameters available. However this stent was also rigid. At the time of writing new stents have become available, specifically aimed at the venous system, like the Zilver vena stent from Cook Medical and the Optimed Sinus Venous. These stents are available in adequate lengths and diameters to treat venous lesions (which are generally found over a longer location). Furthermore, these stents are characterized by high radial force and are very flexible compared to older stent designs. It is our hope that these new materials will increase clinical success rates and simplify treatment techniques.

## CONCLUSION

Interest in and use of minimally invasive treatment in both acute and chronic deep venous pathology is currently increasing exponentially. In cases of PTS with objective (on imaging) vein aberrations post-DVT, endovenous PTA and stenting have shown have shown good clinical success rates with relatively high patency and low morbidity and mortality rates good clinical success rates, with relatively high patency rates and low morbidity and mortality. In cases of venous compression syndromes, without a history of DVT, even better results are obtained. This new field currently shows many interesting developments, with materials specifically designed for the deep venous system becoming available.

### Conflict of Interest

Authors declared no conflict of interest or financial support.
REFERENCES


