Changing Strategies to Treat Venous Thrombotic Occlusions of the Upper and Lower Extremities Secondary to Compressive Phenomena

Adam Spivack MD¹, Doug Troutman DO¹, Matthew Dougherty MD¹, and Keith Calligaro MD¹

Abstract

Objectives: We reviewed our strategies during the last decade for deep vein thrombosis (DVT) of the upper extremity due to thoracic outlet syndrome (TOS) and the lower extremity. Methods: Between 1998 and 2011, we treated 31 patients with 18 subclavian DVTs and 13 iliac DVTs. Management included catheter-directed thrombolysis compared to mechanical thrombolysis (MT; post 2006). Prior to 2006, patients with TOS were treated with total excision of the first rib compared to excision of the anterior half of the rib. Patients were followed up with serial duplex ultrasounds. Results: There was no major morbidity and no mortality in these 31 patients. Three patients developed recurrent DVT but maintained patency after further treatment. Conclusion: Use of MT has led to shorter treatment duration and length of hospital stay. Limiting first rib resection to the anterior half of the rib shortened operative time. Patients requiring stents had excellent long-term patency rates.

Keywords

DVT, venous thoracic outlet syndrome, May-Thurner, Paget-Schroetter syndrome

Introduction

Treatment of deep vein thrombosis (DVT) over the course of the last decade has evolved into a more aggressive paradigm. Treatment of femoropopliteal DVT has generally remained conservative, consisting of administration of anticoagulation with either unfractionated or low-molecular-weight heparin, followed by oral anticoagulation. However, most vascular surgeons have adopted a more aggressive approach to treat more proximal acute DVT, involving the iliac vein or axillary-subclavian vein because of the younger age of most patients and the increased long-term consequences of conservative management with anticoagulation only. Because the most common etiology of acute DVT in these patients is an underlying compression of the axillary-subclavian vein by the first rib (venous thoracic outlet syndrome [VTOS] or Paget-Schroetter syndrome) or of the left common iliac vein by the right common iliac artery (May-Thurner syndrome), an endovascular and/or surgical approach to potentially relieve the compression and provide excellent long-term results has been adopted by most vascular surgeons. Some clinicians continue to favor conservative treatment for iliofemoral DVT, but we believe that a more aggressive paradigm including either prolonged catheter-directed thrombolysis or mechanical thrombolysis (MT) has resulted in better long-term quality-of-life outcomes for patients. ¹ Controversy exists over liberal use of extensive stent placement in the iliac system because of concerns regarding long-term patency of stents anywhere in the venous system. Since these initial concerns, a number of reports have cited the utility of venous stents in iliac veins.²⁻⁴ The VTOS was described initially by Sir Paget and Von Schroetter in late 19th century and is similar to most cases of left-sided iliac DVT in that both pathologies result from extrinsic compression.⁵,⁶ Although catheter-directed thrombolysis remains a standard treatment for VTOS, more efficient strategies have also evolved for this condition.⁷,⁸ Resolution of thrombosis restores blood flow through the axillo-subclavian vein, allowing for the next step in the treatment paradigm, which is resection of the first rib followed by treatment of any persistent stenosis. Controversy persists regarding surgical venoplasty versus stenting in patients with inadequate angioplasty results.

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We report our evolving treatment strategies to manage VTOS and iliac vein DVT over the last decade or so based on our own experience and that reported by others.

Methods

We carried out a retrospective analysis of all patients treated for VTOS and iliac vein DVT due to a compressive etiology from 1998 to 2011 at Pennsylvania Hospital. Data were retrieved from a prospectively maintained vascular registry, and clinical follow-up data were analyzed.

Patients referred for VTOS had usually been treated with catheter-directed thrombolysis (typically 24- to 48-hour infusion) and discharged on anticoagulants. Patients initially evaluated at our center, or who had developed recurrent thrombosis after referral to us, were also treated with catheter-directed thrombolysis early in the series. However, since 2006, we have preferred pharmaco-MT (AngioJet; MEDRAD Inc, Indianola, Pennsylvania) to standard catheter infusion. After successful thrombolysis, we performed first rib resection during the same admission because of the significant likelihood of recurrent thrombosis if surgery is delayed. Two different surgical approaches were used in this series. Earlier in our experience, prior to 2006, we used combined supra- and infraclavicular incisions with complete first rib resection. However, since 2006 we have performed only partial first rib resection, removing the anterior half of the rib through an infraclavicular incision. This minimizes incisional scarring and may also reduce risk for supraclavicular incision such as phrenic nerve, brachial plexus, and thoracic duct injury. At the conclusion of the rib resection, we routinely performed venography using a catheter inserted via an ipsilateral brachial or superficial arm vein. When persistent venous stenosis was documented, endovascular or surgical repair of the proximal subclavian vein was then performed. Since 2006, we have adopted a more liberal approach to stenting for persistent venous stenosis following unsatisfactory balloon angioplasty. This strategy was adopted to avoid the potential morbidity of partial median sternotomy, which may be necessary to gain exposure of the proximal subclavian vein.

Patients with iliac DVT underwent thrombolysis with catheter-directed overnight infusion of tissue plasminogen activator (TPA) earlier in the series. In 2006, we adopted a more aggressive approach using MT initially, with catheter-directed overnight thrombolysis reserved for patients with persistent thrombus. After successful catheter directed or MT, completion venography was performed along with intravascular ultrasound (IVUS). If a residual lesion was seen, surgical venoplasty or balloon angioplasty was performed. In cases after 2006, we adopted a more liberal use of stenting residual iliac vein stenosis, even if this required placing stents across the entire common iliac vein extending into the distal inferior vena cava, the external iliac veins, and in a few cases, under the inguinal ligament into the common femoral vein.

All patients were followed up by venous duplex ultrasound in an Intersocietal Commission for the Accreditation of Vascular Laboratories-accredited vascular laboratory at 1 week, 3 months, 6 months, and annually to assess patency of the veins and to evaluate the need for any intervention. Patients were placed on warfarin (Coumadin) for 6 months postoperatively. If a stent was placed, clopidogrel (Plavix) was administered for 6 weeks as well.

Results

This series included 31 patients with VTOS (18) or iliac vein DVT (13). Subclavian DVTs were secondary to first rib compression in all the cases. Of the iliac DVTs, 10 of 13 were secondary to May-Thurner syndrome (compression of the proximal left common iliac vein by the right common iliac artery crossing anteriorly) and the other 3 were due to compression caused by unknown etiology (2) or spontaneous thrombosis (1). Of the 18 patients with VTOS, there were 11 males with an average age of 35 years (range, 16-60). Of the 13 patients with iliac DVT, there were 9 females with an average age of 41 years (range, 22-63). All patients were followed up with serial clinical examinations and duplex ultrasounds, with a mean follow-up of 1.6 years (1 month to 13 years). The median time of onset of symptoms for the treatment of both iliac and subclavian DVTs was 14 days (iliac DVT: mean, 26 days; range, 0-180 days and VTOS: mean, 29 days; range, 0-104). This reflected the majority of patients being referred to after initial treatment elsewhere. Patients initially diagnosed by our service or in our hospital were treated much sooner on average.

Our treatment strategy to treat iliac DVT changed during the study interval. Iliac stents have been used more liberally since 2006, with 7 of 9 patients receiving stents, while in the years prior to 2006, only 1 of 4 patients was stented (Tables 1 and 2). Of the 3 patients after 2006 that were not stented, iliac vein thrombus resolved with pharmacomechanical thrombectomy alone without concomitant stenosis in 1 patient and with

### Table 1. Lower Extremity DVT Treatment Methods Broken Down by Year and by Procedure.

<table>
<thead>
<tr>
<th></th>
<th>Stent</th>
<th>Open</th>
<th>Balloon (No Stent)</th>
<th>AngioJet Only</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;2006</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>4</td>
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<tr>
<td>&gt;2006</td>
<td>7</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>13</td>
</tr>
</tbody>
</table>

Abbreviation: DVT, deep vein thrombosis.

### Table 2. Lower Extremity DVT by Location and if the Lesion Had a Stent Placed.

<table>
<thead>
<tr>
<th>Location</th>
<th>Left</th>
<th>Right</th>
<th>Stented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common iliac vein</td>
<td>9</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>External iliac vein</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>3</td>
<td>8</td>
</tr>
</tbody>
</table>

Abbreviation: DVT, deep vein thrombosis.
balloon angioplasty alone in another. The third patient underwent balloon angioplasty for a left iliac vein lesion and developed a recurrent DVT 20 days later requiring repeat treatment, this time with stent placement. Of the 13 patients with iliac DVTs, 3 underwent open surgery. One patient was pregnant, contraindicating thrombolysis and underwent venous thrombectomy. The second and third patients had unsuccessful recanalization of a chronic iliac vein obstruction using endovascular techniques.

Another modality that we have used more liberally since 2006 was IVUS. An IVUS was simple to perform and helped to locate occult iliac vein stenosis missed by contrast venography. Prior to 2006, 11 of 11 patients with VTOS underwent a combined supra- and infraclavicular approach with complete first rib resection. After 2006, 7 of 7 patients with VTOS underwent an infraclavicular only approach, with partial anterior first rib resection (Table 3). In the earlier part of the series, only balloon angioplasty or open surgical repair was performed for residual stenosis. More recently, stents have been utilized to treat persistent proximal subclavian vein stenosis following rib resection and balloon angioplasty during the same procedure in 3 patients in preference to surgical repair (see Table 4).

Two wound complications occurred in the total series of 31 patients and were associated with open surgery for iliac DVTs (lymphocele, delayed healing). In the entire series of 31 patients treated for subclavian and iliac DVT, 10.3% (3) developed recurrent thrombosis. In all, 1 of the 13 patients with iliac DVT had a reocclusion of the vein after undergoing thrombolysis and balloon angioplasty without stent insertion but has been symptom free with subsequent stenting of both the common and the external iliac veins. In all, 2 of the 18 patients with VTOS had recurrent DVT. Both patients were initially treated with thrombolysis followed by infraclavicular rib resection and balloon angioplasty alone, despite residual mild-to-moderate stenosis. Recurrent thrombus developed on the first postoperative day in 1 patient and 2 weeks later in the second patient. Both were subsequently treated with repeat pharmaco-MT and stent insertion. Although one of the stented subclavian veins developed recurrent thrombosis requiring further interventions, secondary patency was maintained and remains 100% for the series as a whole, with a mean follow-up of 30 months.

### Discussion

When evaluating patients with iliac DVT, we believe an aggressive treatment strategy should be used to help minimize postphlebitic symptoms. Controversy exists as to patient and lesion factors that inform the decision to deploy venous stents. Some clinicians are particularly hesitant to treat long residual iliac vein stenoses with stents following balloon angioplasty. We have more recently followed Raju’s recommendations regarding liberal stent use for these lesions.

We believe that the most sensitive modality to determine residual stenosis was IVUS, as even biplanar venography can miss flow-limiting lesions. The liberal use of IVUS has directly correlated with our increased use of iliac vein stenting.

Patients with VTOS pose a unique set of challenges for vascular surgeons. Treatment of this condition is a 2-step process, with thrombolysis of the axillary-subclavian vein followed by decompression of the thoracic outlet by first rib resection. Surgical approaches include transaxillary, combined infra- and supraclavicular, and infraclavicular alone. We believe that performing an infraclavicular incision alone is less morbid than the combined approach and affords superior visualization of the vein to the transaxillary approach, with at least equivalent outcomes to these alternatives.

Placement of stents to treat residual venous stenoses associated with VTOS after rib resection and balloon angioplasty is controversial, with scant literature supporting or indicting this approach. However, in a series reported by Stone et al, 11 of the 36 patients had stents placed for residual stenoses. Primary patency rates were 100% after 1 year and 74.4% after 5 years, with secondary patency of 94% after 5 years. In our series of 18 patients with VTOS, 3 patients had stents, and 2 of 3 patients are free from restenosis after 2 and 3 years of follow-up and remain symptom free. One patient who had stent required several reinterventions for recurrent stenosis. Some vascular surgeons recommend direct surgical repair of these lesions with patch angioplasty. However, we have several reservations about this approach. First, some patients have diseased vein segments and residual stenosis after rib resection and balloon angioplasty where a simple patch will not be sufficient to restore lumen diameter. Finding a suitably large vein to replace this segment of proximal subclavian vein is often problematic. Although prosthetic material can be used, we would suggest that an endograft, or covered stent, might yield equivalent patency rates with less morbidity than open surgical repair. Second, although some subclavian vein stenoses can be repaired via the infraclavicular incision, this is rarely possible from the supraclavicular or transaxillary approach. Partial median sternotomy or clavicular head resection may be necessary to afford adequate exposure in some patients. In young patients,

<table>
<thead>
<tr>
<th>Table 3. VTOS Rib Resection Approach.</th>
<th>Table 4. VTOS Venous Treatment Methods.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years</td>
<td>SI</td>
</tr>
<tr>
<td>&lt;2006</td>
<td>8</td>
</tr>
<tr>
<td>&gt;2006</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
</tr>
</tbody>
</table>

Abbreviations: VTOS, venous thoracic outlet syndrome; SI, supraclavicular plus infraclavicular, I, infra, S, supra.

<table>
<thead>
<tr>
<th>TOS</th>
<th>Stent</th>
<th>Balloon Only</th>
<th>Open</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;2006</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>&gt;2006</td>
<td>3</td>
<td>6</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>14</td>
<td>1</td>
<td>18</td>
</tr>
</tbody>
</table>

Abbreviations: VTOS, venous thoracic outlet syndrome; TOS, thoracic outlet syndrome.
this operation can have significant morbidity in terms of quickly gaining normal pain-free arm function. Nonetheless, we recognize that certain patients will be best treated by open surgical repair of the residual proximal subclavian vein stenosis following first rib resection and balloon angioplasty for VTOS. Insertion of a stent does not necessarily preclude the surgeon from performing a veno-veno bypass (such as axillary-jugular vein turndown) in the future if needed.

We recognize that there are several limitations in the study which include the relatively small number in each subset of patients, the limited follow-up, and the retrospective nature of the review. Nevertheless, we believe that certain new trends have appeared in the treatment of these patients over the last decade, and we present this overview of our treatment algorithm for iliac and subclavian vein DVTs due to a compressive etiology.

**Conclusion**

We believe that treatment of DVT due to Paget-Schroetter and May-Thurner syndromes should be approached in an aggressive manner to relieve current symptoms and minimize future morbidity. Increasing use of MT has led to shorter treatment duration and length of hospital stay in this series. Limiting first rib resection to the anterior half of the rib in patients with TOS has reduced operative time and minimized the risk of brachial plexus injury without negative impact on patency. In patients requiring stents to treat residual stenosis following balloon angioplasty, acceptable long-term patency was observed in this series. We recommend that vascular surgeons consider venous stenting when confronted with a recalcitrant venous lesion that may be difficult or complicated to treat with open surgery.

**Authors’ Note**

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**Declaration of Conflicting Interests**

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