Endovascular and Open Surgical Treatment Options for Acute & Chronic DVT and PE

2015 FOMA Mid-Year Seminar
Tampa, Florida

Robert Scott Brumberg D.O., FACOS, RVT
Vascular and Endovascular Surgery
Call to action to prevent venous thromboembolism

Thomas W. Wakefield, MD, Robert B. McLafferty, MD, Joann M. Lohr, MD, Joseph A. Caprini, MD, David L. Gillespie, MD, and Marc A. Passman, MD, on behalf of the Executive Committee of the American Venous Forum, Ann Arbor, Mich; Springfield, Ill; Cincinnati, OH; Chicago, Ill; Rochester, NY; and Birmingham, Ala

Deep venous thrombosis and pulmonary embolism, together called venous thromboembolism, remain a serious national health problem. Estimates suggest that over 900,000 cases occur in the United States per year, with 300,000 deaths per year. Because of the significant and serious nature of this problem, a workshop was held in May of 2006, which resulted in the Acting U.S. Public Health Service Surgeon General’s Call to Action to Prevent Deep Vein Thrombosis and Pulmonary Embolism. On September 15, 2008, Acting Surgeon General, Rear Admiral Steven K. Galson, MD, MPH, and Elizabeth Nabel, MD, Director National Heart, Lung, and Blood Institute, announced the Call to Action. The Call to Action highlights public awareness about the risk factors, triggering events, and symptoms of venous thrombosis and pulmonary embolism, and encourages the development of evidence based practices for screening, prevention, diagnosis, and treatment of venous thrombosis and pulmonary embolism. It is designed to encourage new scientific investigation in an effort to obtain needed evidence to fill in the gaps of knowledge about venous thrombosis and pulmonary embolism. This knowledge should be quickly and easily disseminated to the public and put into practice by health professionals. The Surgeon General’s Call to Action represents one of the most important advances in the field of venous thromboembolism and sets the stage for multidisciplinary efforts to combat this serious national health problem. (J Vasc Surg 2009;49:1620-3.)
**ACCP Guideline Updates**

**What The New ACCP Guidelines Advise**

1.8 Treatment Strategies For Thrombus Removal for Acute DVT.
Treatments that actively remove thrombus in patients with acute DVT have the potential to reduce acute symptoms and the risk for PTS. Thrombus removal directly reverses venous obstruction and can restore function in valves that were immobilized by thrombus. Indirectly, early removal of thrombus obstruction can prevent late development of venous valvular incompetence secondary to venous dilation in distal venous segments that were never involved with thrombosis\(^1\). Randomized trials\(^2\)\(^3\)\(^4\)\(^5\)\(^6\)\(^7\), patient registries\(^8\)\(^9\) and studies of other design\(^1\)\(^2\)\(^3\)\(^4\)\(^5\) support that successful thrombus removal, using a variety of techniques can improve patient outcomes\(^1\)\(^7\)\(^8\)\(^9\)\(^10\)\(^11\). It is also possible that thrombus removal and relief of venous obstruction may reduce the risk of recurrent VTE. Patients with iliofemoral DVT are the subset of patients with the largest thrombus burden and highest risk for postthrombotic morbidity, with up to 75% having chronic painful edema and 40% having venous claudication when treated with anticoagulant therapy alone\(^1\)\(^2\)\(^3\)\(^4\)\(^5\).

1.9.1. In selected patients with extensive acute proximal DVT (eg, iliofemoral DVT, symptoms for < 14 days, good functional status, life expectancy > 1 year) who have a low risk of bleeding, we suggest that CDT may be used to reduce acute symptoms and post-thrombotic morbidity if appropriate expertise and resources are available.

1.9.3. We suggest pharmacomechanical thrombolysis (eg. with inclusion of thrombus fragmentation and/or aspiration) in preference to CDT alone to shorten treatment time if appropriate expertise and resources are available.
Venous Post-Thrombotic Pathophysiology
Post - Thrombolytic Syndrome

43% of DVT patients develop PTS¹

25-33% of patients with PTS develop ulcers and skin deterioration²

75% of DVT treatment cost is related to PTS¹

PTS is a permanent disability

PTS is a chronic condition like arthritis, chronic lung disease and angina

The Evolution of DVT Treatment

1950 ~ 1980
Anticoagulation Therapy

1980
Systemic Thrombolysis

1990
Catheter Directed Thrombolysis

2000
Pharmaco-mechanical Thrombolysis

Today
Isolated Pharmaco-mechanical Thrombolysis
Current Advances in Anticoagulation for treatment of DVT

- **VKA**
  - Warfarin (Coumadin)
- **Xa inhibitors**
  - Rivaroxaban (Xarelto)
  - Apixaban (Eliquis)
  - Edoxaban (Sanvaysa)
- **IIa inhibitors**
  - Dabigatran (Pradaxa)
Multiple clinically based studies for the supporting the use of anticoagulation for acute & symptomatic DVT. However...
Anticoagulation is not enough!

...does prevent clot propagation.
...does reduce risk of pulmonary embolism.
...does not resolve clot.
...does not prevent valvular damage.
...does not prevent venous hypertension.
...does not rapidly resolve symptoms.
...does not prevent PTS.
Anticoagulation Alone vs CDT thrombolysis
Srinivas, Patra, Nagesh et al

- 51 patients: 26 AC vs 25 CDT w/AC
- Streptokinase utilized during CDT treatment
- Mean duration of CDT was 108 hours (SD 32hrs)

Conclusions

- Grade 2 (50-90% lysis) in 63% of patients
- Grade 3 (complete lysis) in 37% of patients
- After 6 months:
  - Iliofemoral patency: 20 (80%) in CDT group vs 7 (23%) in AC
  - PTS: 5 (20%) in CDT group versus 19 (77%) in AC group
Anticoagulation Alone vs CDT thrombolysis
Enden, Klow, Sandvik, et al

- 103 patients: AC 53 vs CDT/AC 50

Conclusions
- Grade 2 (50-90% lysis): 20 patients
- Grade 3 (complete lysis): 24 patients

After 6 months
- Iliofemoral patency: 32 (64%) CDT vs 19 (36%) AC
- Absolute risk reduction for rDVT: 28%
- Recurrent DVT from Venous obstruction was found in 10 (20%) CDT vs 26 (49%) AC
Why endo-surgical treatment of Acute DVT and chronic venous disease?

- Prevent long term complications of resolving DVT S/S including:
  - Persistent pain in extremity
  - Edema and swelling
  - Skin matting and hyperpigmentation
  - Ulceration and venous gangrene
  - Ambulatory Venous Hypertension leading to venous insufficiency and reflux

- Cost to health care: $1 billion dollars*
- Cost for wound care: $40,000 a year per patient*

(*source: American Venous Forum 2012)
**IVC Filter Indications**

*American Venous Forum Guidelines 2009*

**BOX 25.1 Indications for inferior vena cava (IVC) filter placement**

**Common indications**
- Contraindication to anticoagulation in patients with pulmonary embolism (PE)/deep vein thrombosis (DVT)
- Complications of anticoagulation
- Failure of anticoagulation due to progression of DVT, recurrent PE, or noncompliance
- Massive, life-threatening PE with residual DVT despite anticoagulation
- Free-floating thrombus in IVC, iliac or pelvic veins
- Chronic, recurrent PE with pulmonary hypertension and cor pulmonale

**Indications specifically for prophylactic IVC filter**
- Patients with prior PE with significantly increased risk for second PE or those with poor cardiopulmonary reserve
- Patients with a significant burden of proximal DVT or free-floating thrombus
- Patients at high risk for complications of thromboembolism (malignancies and major/multiple trauma)
- Patients who cannot receive anticoagulants (internal organ injury, active internal bleeding)
- Multiple risk factors for DVT in a preoperative patient
Figure 21.3  Suggested algorithm for the treatment of acute iliofemoral deep venous thrombosis. *Percutaneous mechanical thrombolysis; †catheter-directed thrombolysis.
Iliocaval Stenting for Advanced Chronic Venous Disease

Stenting iliac vein lesions on the basis of clinical suspicion and IVUS.

BY JOSE I. ALMEIDA, MD, FACS, RPVI, RVT, AND CRISTAL BOATRIGHT, MMS, PA-C

The etiology of venous obstruction can be primary (nonthrombotic) or secondary (postthrombotic), with roughly equal prevalence estimates in patients with chronic venous disease (CVD). Signs and symptoms of chronic venous obstruction and reflux overlap with some differences. Varicose veins, edema, lipodermatosclerosis, and ulceration can occur with either pathology. Limb swelling beyond ankle edema is rare with pure superficial reflux alone. Combined reflux/obstruction is commonly present in either etiology, however, obstruction alone without reflux occurs in approximately one-third of primary etiology cases.5

Primary obstruction, often referred to as nonthrombotic iliac vein lesions (NIVLs), usually arises from compression of the left common iliac vein by crossing of the overlying right common iliac artery. Other compression sites commonly occur at proximal or distal locations such as the hypogastric artery bifurcations. Webs and membranes resulting from traumatic injury by pulsations of the intimately related artery are frequently present as well. Such lesions are present in 30% to 50% of the general population, but symptom expression occurs in 3% to 5% of cases when additional insult, such as trauma, infection, or reflux, is added.6,7

Percutaneous endovascular stenting has emerged during the last decade as the method of choice to treat femorocaval venous outflow obstruction due to CVD. Accurate hemodynamic tests are unavailable, thus diagnosis and treatment must be based on clinical suspicion and morphologic ultrasound findings.

METHODS
Forty-two limbs with signs and symptoms of advanced CVD were evaluated via intravascular ultrasound (IVUS) with an intent-to-treat protocol and were followed prospectively. In the operating room, the

Figure 1. The aorta (above) and the inferior vena cava (below).

Figure 2. The aortic bifurcation (above) and common iliac vein confluence (below). Notice the right common iliac artery crossing over the left common iliac vein.

Figure 3. The right common iliac artery (above) compressing the left common iliac vein (below).
Combined superior ablation and iliac stent placement for complex severe chronic venous disease

Peter Neglen, MD, PhD, Kathryn C. Hollis, BA, and Seshadri Raju, MD, Jackson, Miss

Factors associated with outcome after interventional treatment of symptomatic iliac vein compression syndrome

Brian S. Knipp, MD, Eric Ferguson, MD, David M. Williams, MD, Narasimham J. Dasika, MD, Wojciech Cwikel, MD, Peter K. Henke, MD, and Thomas W. Wakefield, MD, Ann Arbor, Mich

Obstructive lesions of the inferior vena cava: Clinical features and endovenous treatment

Seshadri Raju, MD, Kathryn Hollis, BA, and Peter Neglen, MD, PhD, Flowood, Miss

Mid-term results of endovascular treatment for symptomatic chronic nonmalignant iliocaval venous occlusive disease

Olivier Hartung, MD, Andres Otero, MD, Mourad Boufi, MD, Giovani Decaridi, MD, Pierre Barthelemy, MD, PhD, Claude Juhan, MD, and Yves S. Alimi, MD, PhD, Marseille, France
Percutaneous recanalization of total occlusions of the iliac vein

Seshadri Raju, MD, a and Peter Neglén, MD, PhD, b Jackson and Flowood, Miss

Bilateral stenting at the iliocaval confluence

Peter Neglén, MD, PhD, a Rikki Darcey, BS, a Jake Olivier, PhD, b and Seshadri Raju, MD, a Flowood, Miss; and Sydney, New South Wales, Australia

Venous stenting across the inguinal ligament

Peter Neglén, MD, PhD, T. Paul Tackett Jr, BS, and Seshadri Raju, MD, Flowood, Miss

Stenting of the venous outflow in chronic venous disease: Long-term stent-related outcome, clinical, and hemodynamic result

Peter Neglén, MD, PhD, a Kathryn C. Hollis, BA, a Jake Olivier, PhD, b and Seshadri Raju, MD, b Jackson, Miss
Clinical Evidence Conclusions

- Percutaneous recanalization of iliac occlusions is feasible in over 90% of patients presenting regardless of primary cause.
- Braided stainless stents can be placed across the inguinal ligament with good long term patency.
- Always stent from “good vein” segment to “good vein” segment.
- Chronic ilio-caval confluence obstruction is best managed by “double-barrel” stenting technique when feasible, but no optimal solution exists. Keeping the confluence patent is paramount.
- Stent placement across the renal and hepatic veins had no long-term morbidity nor adverse sequelae.
- Temporary Suprarenal filter placement is a useful tool for planned thrombolysis.
- Symptomatic relief of patients is the single best parameter of a successful result.
Stenting of chronically obstructed inferior vena cava filters

Peter Neglén, MD, PhD,* Mathew Oglesbee, BS,a Jake Olivier, PhD,b,c and Seshadri Raju, MD,a Flowood, Miss; and Sydney, Australia

Objectives: A protective inferior vena cava (IVC) filter may later be incorporated into a chronic postthrombotic ilio-caval obstruction (occlusive, requiring recanalization, or nonocclusive). This study aims to assess the safety and stent-related outcome following stenting across an obstructed filter.

Methods: From 1997 to 2009, 708 limbs had stenting for postthrombotic ilio-caval outflow obstruction (occlusion in 121 limbs). In 25 patients, an IVC filter was obstructed (Group X). The site was crossed by a guidewire and balloon dilated. The filter was markedly displaced sideways or remodeled. A stent was placed across the IVC filter and redilated. In 28 other patients, the cephalad stenting terminated below a patent IVC filter (Group B). The remaining 655 patients had no previous IVC filter placement (Group no IVC filter present [NF]). The patients were followed to assess patency. The types of reintervention were noted.

Results: The stenting maneuver through a variety of previously inserted IVC filters was safely performed without an apparent tear of the IVC, no clinical bleeding or abdominal symptoms, or pulmonary embolism. Mortality was nil; morbidity minimal. The primary and secondary cumulative patency rates at 54 months for limbs with postthrombotic obstruction were with and without IVC filter (38% and 40%; P = .1701 and 79% and 86%; P = .1947, respectively), and for limbs with stenting across the filter (Group X) and stent termination below the filter (Group B; 32% and 42%; P = .3064 and 75% and 84%; P = .2788, respectively), not statistically different. When Group X alone was compared with Group NF, the secondary patency rate was, however, significantly lower (78% vs 86%; P = .0453), suggesting that crossing of the stent was associated with reduced patency.CLUSIVE postthrombotic disease requiring recanalization was more frequent in Group X than in Group B and Group NF (68%, 25%, and 16%, respectively; P = .004). A comparison was therefore performed only between limbs stented for recanalized occlusions with (n = 25) and without IVC filters (n = 92) showing no difference (cumulative primary and secondary patency rates 30% and 35%; P = .9678 and 71% and 73%; P = .9319, respectively). Multiple logistic regression analysis also supported a significant association between patency rate and occlusive disease (odds ratio, 6.9; 95% confidence interval, 3.4-15.9; P < .0001), but not between patency rate and presence of an IVC filter (P = .5552).

Conclusions: Stenting across an obstructed IVC filter is safe. It appears that patency is not influenced by the fact that an IVC filter is crossed by a stent, but is related to the severity of postthrombotic disease (occlusive or nonocclusive obstruction) and the associated recanalization procedure. (J Vasc Surg 2011;54:153-61.)
Neglen, Oglesbee et al.  
JVS, July 2011

- From 1997-2009, 708 limbs studied for ilio-caval obstruction.
- 25 patients had an IVC filter obstruction and thrombosis. Stents placed across the IVC filter and redilated the track.
- Comparisons were made to caval obstructions below a filter and non-filtered IVC caval occlusions for patency and low-term morbidity.

Results

- Primary patency for Stented Filter was 32% vs 42% for stent below filter (p=0.3)
- Secondary patency was 75% vs 84% for same groups.
- Secondary patency was reduced in comparison to a non-filtered group (75% vs 86%)

Conclusions

- Stenting across an obstructed IVC filter is safe.
- Patency is more influenced by post-thrombotic disease and recanalization than actual IVC filter stenting.
# American Venous Forum Guidelines

## Guidelines 4.17.0. of the American Venous Forum on endovascular reconstruction for chronic iliofemoral vein obstruction

<table>
<thead>
<tr>
<th>No.</th>
<th>Guideline</th>
<th>Grade of recommendation (1, we recommend; 2, we suggest)</th>
<th>Grade of evidence (A, high quality; B, moderate quality; C, low or very low quality)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.17.1</td>
<td>For chronic iliac vein obstruction we recommend endovenous stenting to improve symptoms and the quality of life of the patients</td>
<td>1</td>
<td>A</td>
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## Guidelines 4.18.0. of the American Venous Forum on endovascular reconstruction of complex iliocaval venous occlusions

<table>
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<th>Guideline</th>
<th>Grade of recommendation (1, we recommend; 2, we suggest)</th>
<th>Grade of evidence (A, high quality; B, moderate quality; C, low or very low quality)</th>
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</thead>
<tbody>
<tr>
<td>4.18.1</td>
<td>We suggest endovascular stents for reconstruction of complex iliocaval venous occlusions</td>
<td>2</td>
<td>B</td>
</tr>
</tbody>
</table>
Hospital Based DVT Treatment

**Old School**
- Admit to in-patient stay in hospital
- Intravenous Heparin
- Bridge to Coumadin (5-7 days)
- Up to one-week admission for anticoagulation in hospital

**New School**
- Admit to Interventional Suites from ER
- Fluoroscopic treatment for thrombolysis
- 23hr observation admission
- Outpatient bridge on VKA or NOAC
## Table 11—[Section 2.9, 2.10, 5.6, 9.2] Risk Factors for Bleeding With and Contraindications to Use of Thrombolytic Therapy (Both Systemic and Locally Administered)

<table>
<thead>
<tr>
<th>Major contraindications&lt;sup&gt;a&lt;/sup&gt;</th>
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<tbody>
<tr>
<td>Structural intracranial disease</td>
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<tr>
<td>Previous intracranial hemorrhage</td>
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<tr>
<td>Ischemic stroke within 3 mo</td>
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<tr>
<td>Active bleeding</td>
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<tr>
<td>Recent brain or spinal surgery</td>
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<tr>
<td>Recent head trauma with fracture or brain injury</td>
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<tr>
<td>Bleeding diathesis</td>
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<table>
<thead>
<tr>
<th>Relative contraindications&lt;sup&gt;b&lt;/sup&gt;</th>
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<tbody>
<tr>
<td>Systolic BP &gt; 180 mm Hg</td>
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<tr>
<td>Diastolic BP &gt; 110 mm Hg</td>
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<tr>
<td>Recent bleeding (nonintracranial)</td>
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<tr>
<td>Recent surgery</td>
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<tr>
<td>Recent invasive procedure</td>
</tr>
<tr>
<td>Ischemic stroke more that 3 mo previously</td>
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<tr>
<td>Anticoagulation (eg, VKA therapy)</td>
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<tr>
<td>Traumatic cardiopulmonary resuscitation</td>
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<tr>
<td>Pericarditis or pericardial fluid</td>
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<tr>
<td>Diabetic retinopathy</td>
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<tr>
<td>Pregnancy</td>
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<tr>
<td>Age &gt; 75 y</td>
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<tr>
<td>Low body weight (eg, &lt; 60 kg)</td>
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<tr>
<td>Female sex</td>
</tr>
<tr>
<td>Black race</td>
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</tbody>
</table>
Lower Extremity

Infrarenal IVC
Common Iliac
External Iliac
Common Femoral
Superficial Femoral
Popliteal
Tibial Vein with confirmation of proximal system involvement
Upper Extremity

- Left innominate v.
- Int. jugular v.
- Subclavian v.
- Cephalic v.
- Sup. intercostal v.
- Sup. vena cava
- Axillary v.
- Arch of the azygos v.
Device Adjuncts for Thrombus Clot Extraction

- Possis Angiojet
- EKOS
- Trellis
- AngioVac
- Extraction Catheters
- Intravascular Ultrasound
Possis Angiojet Device
Catheter Directed Thrombolysis

✓ Creates free fluid flow through the catheter system, pulling thrombus to inflow windows

✓ Thrombus becomes fragmented from jet saline or thrombolysis infusion

✓ Thrombus becomes microscopic and absorbed by the body

✓ Usually requires 12-24 hours infusion with lysis catheter if not resolved after initial treatment
EKOS Device
Pharmacomechanical Thrombolysis

✓ Ultrasound microsonic energy is generated in the thrombus to release fibrin strands.

✓ Antithrombolytics are infused through the microsystem in conjunction with ultrasound waves to increase permability of clot dissolution.

✓ Requires 12-24 hours of thrombolysis with f/u venography.
Isolated thrombolysis catheter with two occluding balloons.

Infusion of thrombolytic to a specific venous segment with isolated thrombolytic without systemic perfusion.

Ultrasonic movement of catheter breaks fibrin strands and increases clot dissolution at segmental units.

Overnight infusion only with unsatisfactory result.
AngioVac Device
Macro-mechanical Large Volume aspiration & extraction

- Isolated large volume clot extraction
- For Aortic and IVC extensive clot burden
- For IVC filter occlusion
- Requires GA and operating room
- Requires Perfusion assistance
- Jugular & Femoral 22fr sheath access
AngioVac Device
Pronto Extraction Catheters
Small Bore aspiration
Intravascular Ultrasound

✓ Allows for inside view of vessel wall and thrombus burden
✓ Assists in sizing for PTA and stenting of stenotic vessels
✓ Ensure reduction of clot burden and patency of vessels treated.
Case Studies
“Criteria” for Acute Thrombolysis

- DVT confirmed within 30 days at time of diagnosis
- No contraindication for isolated thrombolysis
- Co-morbid conditions that favor thrombolysis success (medical judgement)
- Lower and Upper Extremity DVT within the deep systems only
Technique of Procedure

- Temporary IVC filter placement via non-involved femoral vein, popliteal or jugular approach
- Prone positioning & ultrasound guided lesser saphenous or directed popliteal venous access
- Fluoroscopic guided thrombolysis with appropriate device
- Follow-up venogram and ultrasound
- Post-operative anticoagulation based upon clinical results
Case #1: 83 y/o male with acute on chronic Iliofemoral DVT

Pre-op Venogram

Post-op Venogram after Trellis, PTA and stenting.
Case #2: 34 y/o female 2 months postpartum with complete Right Popliteal, SFV, CFV, Iliac, & infrahepatic IVC DVT with Ovarian Vein thrombosis
Case #2: 34 y/o female with complete Right Popliteal, SFV, CFV, Iliac, & infrahepatic IVC DVT with Ovarian Vein thrombosis.
Post-op Venogram s/p Trellis and Angiojet Thrombectomy with Isolated Pharmacomechanical Thrombolysis
Successful Clot Extraction!!!
Post-op CT on HD#5 with DVT resolution
Case #3: 75 y/o male with hx of three months bilateral leg swelling

Clotted IVC Filter

Bilateral Iliac vein thrombosis
Case #3: Primary Venogram with Suprarenal Filter Placement

Clotted IVC Filter
Case #3: 24 hours post Right & Left Leg

Right Leg SFV (Lysis)  
**Pre**  
**Post**  

Left Leg SFV (EKOS)  
**Pre**  
**Post**
Case #3: Completion Venogram

PTA

Stenting

Right Leg
EIV & CIV

Stenting

Left Leg
EIV & CIV
Case #4: 78 y/o male with 3 month history of left leg swelling s/p suprapubic bladder stimulator removal

Left Leg

SFV

CFV

EIV
Case #4: Post 24 hr Venogram s/p EKOS and Angiojet thrombolysis

SFV

SFV to CFV

EIV to IVC
Case#4: Completion Venogram with Viabahn Stent Placement
SFV to EIV

Residual Clot

Viabahn 11 x 5 x2 followed by 9 x 10
Completion Venogram with patent venous system

Hypogastric venous reflux with patent central veins
Case #5: 78 year old female with 1 month of continual bilateral leg swelling

- Clotted IVC Filter
- Bilateral Iliac vein thrombosis
- Suprafilter thrombus
Case #5: Right Leg Venogram after 24hr lysis infusion and angioplasty.
Case #5: Left Leg Venogram after 24hr EKOS infusion and angioplasty.

Patent Left SFV, CFV, EIV, CIV and IVC
Case#5: Completion Venogram

Patent bilateral Iliac stenting into IVC

Decrease filling of collaterals secondary to outflow patency
Case #6: 46y/o male with one month hx of recurrent LLE swelling s/p IVC Filter, Trellis and WallStent Placement from LLE DVT s/p Lumbar Disc Fusion at OSH.

Thrombosed L CIV stent & IVC filter and Cava
Pre-Thrombolysis Venogram

Wall Stent Compression

L Popliteal and SFV thrombosis to Cava

Importance of IVUS evaluation
Post EKOS Thrombolysis

Patent L Popliteal thru Iliac Vein

Patent L CIV with stent by Venogram
Post stent PTA Molding
Post PTA/Stent
Procedural Hints

• Pre-op CT and MRV can be helpful for endovenous planning.
• Jugular & Contralateral Illiac approach can help cross occlusions.
• Be open to use multiple devices and catheters to open obstructions.
• Intravascular Ultrasound for patency and stent sizing.
• Supra- IVF filter placements above current occlusion.
• May need multiple treatments to obtain satisfactory results.
• Always stent from “good vein” to “good vein” and can be across joint space.
• No correct method for Vena Cava stent placement. Maintaining patency is of most importance.
Open Surgical Thrombectomy

- Can be clinically indicated in symptomatic patient with endovenous failure
- Phlegmasia alba dolens (major veins)
- Phlegmasia cerulea dolens (major and collateral venous channels)
- May-Thurner Syndrome (Iliac Vein Compression)
- Milk Leg Syndrome (3rd trimester)
- Compartment syndrome from acute DVT
Pulmonary Emboli
Catheter Directed Thrombolysis
ACCP 2012 Recommendations

Demographics

• In the US, 530,000 cases of symptomatic PE
• Approximately, 300,000 deaths each year
• Mortality rate > 58% with acute PE w/ shock
• 3rd most common death among in-patients
• Death can occur within 1 hour of presentation
MPE/SPE Pulmonary Emboli
Catheter Directed Thrombolysis
ACCP 2012 Recommendations

Initial ECHO at presentation:

- RV/LV ratio > 1
- Mean PAP > 25mmHg (CTPH)
- Tricuspid Regurgitation
- RV dilatation
- CI compromise

5.7. In patients with acute PE associated with hypotension and who have (i) contraindications to thrombolysis, (ii) failed thrombolysis, or (iii) shock that is likely to cause death before systemic thrombolysis can take effect (eg, within hours), if appropriate expertise and resources are available, we suggest catheter-assisted thrombus removal over no such intervention (Grade 2C).

5.8. In patients with acute PE associated with hypotension, we suggest surgical pulmonary embolectomy over no such intervention if they have (i) contraindications to thrombolysis, (ii) failed thrombolysis or catheter-assisted embolectomy, or (iii) shock that is likely to cause death before thrombolysis can take effect (eg, within hours), provided surgical expertise and resources are available (Grade 2C).
Akin, Al-Jubouri, Comerota. Et. Al. AVS, 2014

- 17 Patients treated with CDT for MPE & SPE
- All had elevated PAP at presentation and symptomatic SOB
- All had RV dilatation and reduced EF on ECHO

RESULTS
- Post procedures: normalized in 74% and improved in 24%
- LV underfilling function improved & normalized after CDT
- TR improved in 60% of MPE and 58% of SPE

Conclusions:
- In symptomatic patients, CDT is a successful adjunct in the acute management for MPE and SPE.
- CDT rapidly restores CP hemodynamics using reduced doses of tPA
Kucher, Boekstegers, et. al. Circulation 2014

• 59 patients studied:
  – with acute main or LL PE and RV/LV ratio >1.0
  – Randomized to systemic heparinization vs CDT

Results

• CDT group mean RV/LV ratio reduced from 1.28 to 0.99 at 24hr vs 1.2 to 1.17 in medicine group
• Mean decrease in ratio was 0.3 in CDT vs 0.03 in Medicine group

Conclusions

• In patients with PE at intermediate risk, CDT was superior to systemic heparin to reversing RV dilatation
Clinically Supported Evidence

Catheter-directed interventions for acute pulmonary embolism

Efthyemios D. Avgerinos, MD, Rabih A. Chaer, MD
Division of Vascular Surgery, University of Pittsburgh Medical Center, Pittsburgh, Pa
Received: July 6, 2014; Accepted: October 16, 2014; Published Online: December 16, 2014
Peter F. Lawrence, MD, Section Editor

Ultrasound-Accelerated Catheter-Directed Thrombolysis for Acute Submassive Pulmonary Embolism

Sandeep Bagla, MD, John B. Smiriotopoulos, MD, Arletta van Breda, MSN, Michael J. Sheridan, ScD, Keith M. Sterling, MD
K.M.S. is a paid consultant for BTG.

Pulmonary Embolism Response to Fragmentation, Embolectomy, and Catheter Thrombolysis (PERFECT): Initial Results from a Prospective Multicenter Registry

William T. Kuo, MD; Arjun Banerjee, BS; Paul S. Kim, MD; Frank J. DeMarco, Jr, MD; Jason R. Levy, MD; Francis R. Facchini, MD; Kamil Unver, MBiomedE, MBA; Matthew J. Bertini, MD; Akhilesh K. Sista, MD; Michael J. Hall, MD; Jarrett K. Rosenberg, PhD; Miguel A. DeGregorio, MD, PhD
RV Strain on ECHO

Pre-CDT treatment

Post-CDT treatment
Pulmonary Angiography
Conclusions

- Lower extremity acute DVT and occlusions are very morbid chronic venous conditions that if untreated lead to venous ulcerations and PTS.
- Wound care costs for PTS associated with venous obstruction and ulceration has increased.
- Acute & Chronic venous obstruction can be treated successfully with the endovascular and hybrid approach with good clinical results.
- Appropriate patient selection of PE thrombolysis can help prevent CTPH & improve RV function.
- The 3 P's: Patience, Persistence and Perseverance will dictate successful outcomes.