

# Deep Venous Thrombosis: Evaluation and Management, Duplex, CTV, MR Venograms, Lysis and Stenting

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## Incidence

- Every year over 900,000 VTE events occur in the US
  - Data is based on a study of 12.7 million people
  - Incidence of VTE = 1.57%
  - 330,000,000 in the US, x 1.57%= >5 million, but includes children, etc.
- As the US population continues to age that number is expected to double by 2050
- Up to 100,000 deaths from VTE/year in US
- Majority occur in patients with PE, however, initial presentation sudden death in 25%
- Approximately 50% of those presenting with PE were dead at 90 days

Roger et al: Circulation 2012  
CDC and Prevention 2015



## What is PTS?

- Susan Kahn. *The post-thrombotic syndrome*. Hematology 2016, Dec 2
- Important consequence of Deep Venous Thrombosis
- Develops in up to 50% of patients post DVT, even when best practice treatments are followed
- Manifestations vary from mild pain and swelling to chronic disabling leg pain, intractable swelling and ulcers (5-10%)
- PTS adversely affects quality of life, productivity and has major downstream financial impact



## What causes this?

- Felt to be a result of venous hypertension in the leg, both by venous obstruction and valvular reflux due to valve damage
- Standard anticoagulation of DVT does not lead to direct reduction in thrombus burden and does not impact local inflammation
- May also be a genetic prevalence, associated with congenital causes of DVT



## Diagnosis

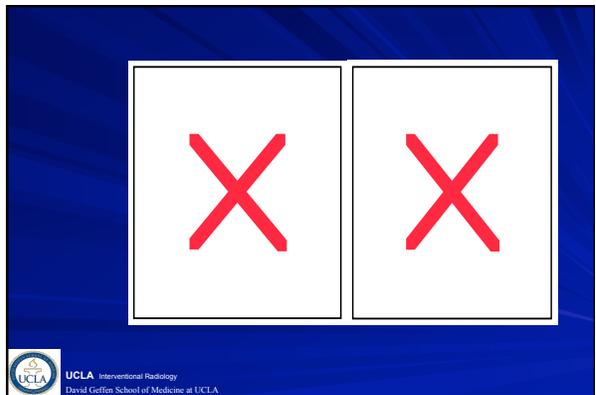
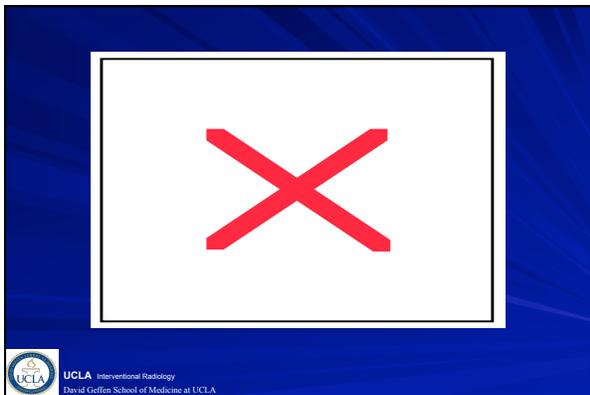
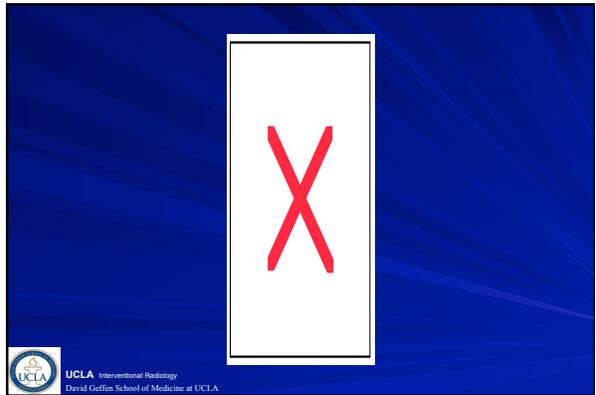
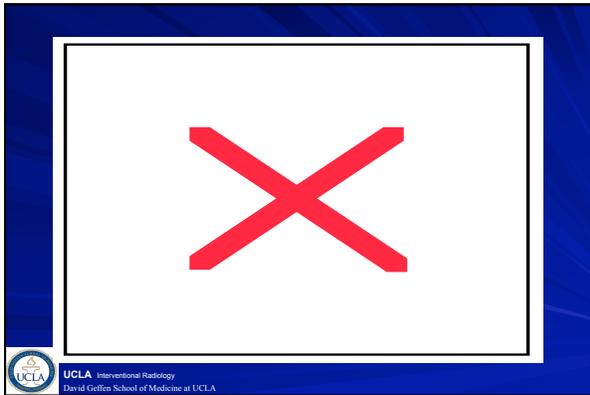
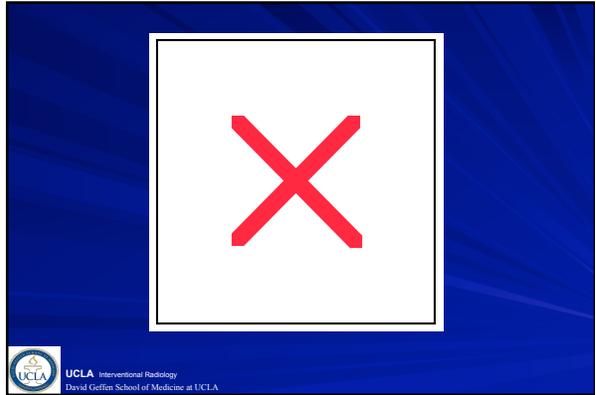
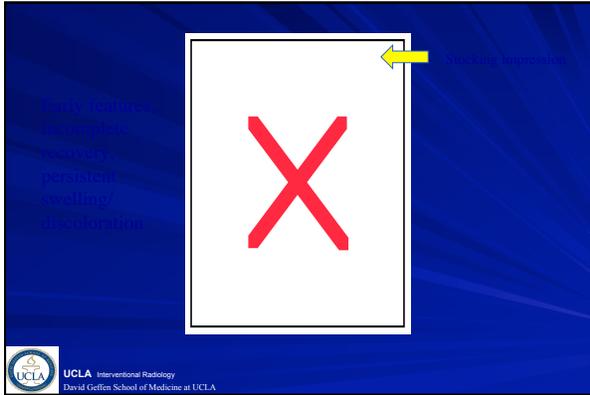
- No gold standard biomarker, test, or imaging study for PTS
- It can take 3-6 months for the acute symptoms associated with an acute DVT to improve, therefore diagnosis of PTS is usually deferred for 6-24 months
- Villalta-Prandoni scale has been developed to diagnose and grade severity

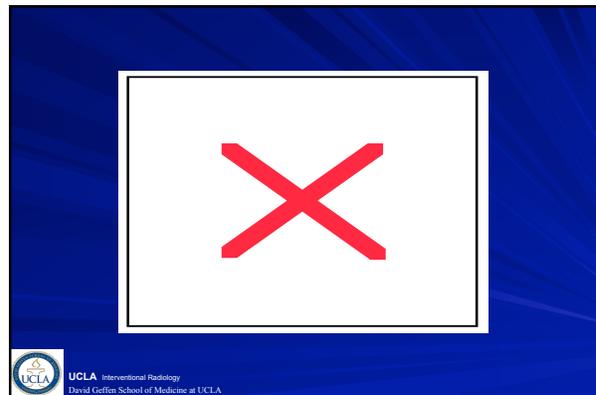
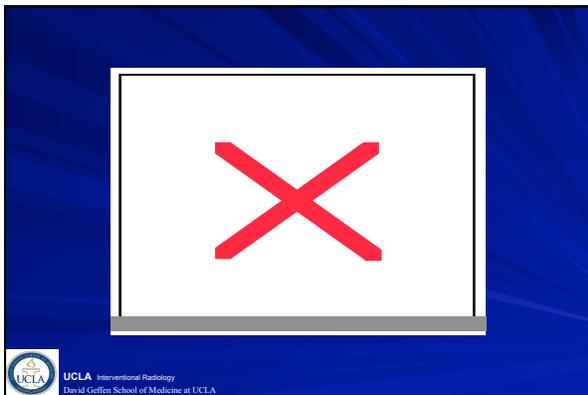
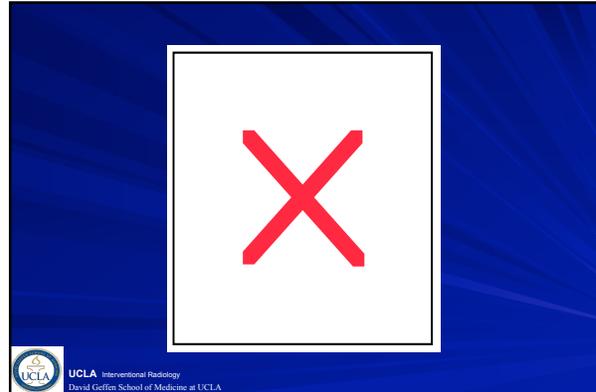
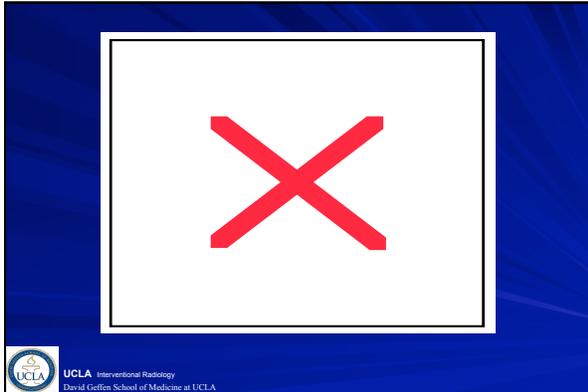


## Risk factors for PTS

- DVT location: 2-3 times more common if DVT extends above knee
- Prior DVT, and particularly if symptoms persist > 1 month
- Pre-existing venous insufficiency, 2 times incidence
- Elevated BMI, up to twice the risk
- Older age
- Residual thrombosis on follow-up Ultrasound, 1-6 months, this was also seen in the ATTRACT trial







## PTS by Villarta

- Any score of  $\geq 4$  or presence of an Ulcer = PTS
- Attract trial used a score of  $\geq 5$  as diagnostic
- Other scoring systems, CEAP: Clinical, Etiology, Anatomy, Pathophysiology
- How it looks, inherited or not, which veins, N or abN flow

## Can PTS be prevented?

- Better thromboprophylaxis in high-risk patients
- Better anticoagulation to prevent recurrence
- ECS, controversial, 2 small trials promoted use, but large SOX trial of 803 patients showed no benefit in prevention
- Now mainly to help mitigate symptoms after PTS has been diagnosed
- What about thrombolysis? See ATTRACT! Recent long term CAVENT data did show reduced PTS in PCDT patients

## Role of Imaging

- Duplex Ultrasound is used to diagnose the initial DVT that subsequently gives rise to the PTS
- When the PTS has occurred Duplex can be used to identify the extent of venous thrombosis or/and occlusion, and to guide the site of puncture and degree of intervention needed
- Role of diagnosis of reflux in patients with PTS is poorly understood, patients with leg pain may have erect study to evaluate valvular function, with potential sclerotherapy in mind



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## Sclerotherapy

- No role for superficial vein ablation in patients with reflux and PTS
- In fact obliteration of the VV could lead to considerable worsening of the condition, now both occluded deep and superficial veins
- In fact, since there appears to be limited role for ECS in PTS no real indication for a Duplex Reflux study



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## Role of CT Venography

- Main indication for cross-sectional imaging is to evaluate the Pelvic Veins
- Duplex is extremely effective in imaging up to the CFV, but struggles to clearly identify and interrogate the Iliac Venous system
- Improvements and increased availability in MR imaging have relegated CT to patients with implanted hardware or claustrophobia
- Can be used when PE studies are being performed to assess Pelvic and upper thigh veins



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## MR Venography

- *Arnoldussen et al. Assessment of the Postthrombotic Syndrome using MR Veography and DUS: The Correlation with Clinical Scoring Systems, VCSS, Villalta and CEAP. Abstract, JVS, January 2013*
- MR venography considered extremely useful and accurate in identifying venous abnormalities seen on Duplex, with the added benefit of visualization of Pelvic Venous abnormalities
- In our practice, chronic DVT patients, all of whom by definition have PTS, have an MRI (with contrast, MRV) to assess patency of both deep and superficial channels, extent of pelvic and caval abnormalities



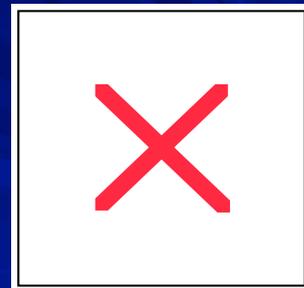
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## Imaging for May-Thurner Syndrome

- What to do in asymptomatic patients?
- Should you look in treated Left leg DVT?
- Can you see it without DVT, but with symptoms?
- Should you stent everyone, if not who?

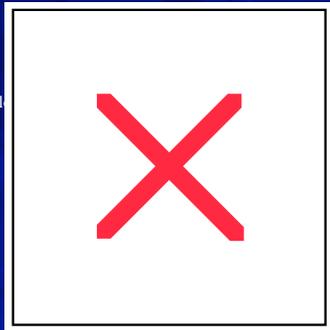


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Asymptomatic  
29 year old male



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## Asymptomatic Presentation

- May and Thurner found compression in 1/5-1/3 cadavers
- Present in 1/5-1/2 patients with Left-sided DVT, depends how you define it, probably 1/5-1/4 if use significant compression, >70% stenosis, on IVUS
- Cheng et al performed CT scans on 500 asymptomatic patients (Cheng et al. Iliac Vein Compression Syndrome: in asymptomatic patients: a prospective study. Chin Med J 2017)
- ≥ 50% stenosis in 10%, more common in young females
- Followed for 40 months, 6/50 patients ≥ 50% stenosis had thrombotic issue Vs 11/450, but overall low incidence 3%



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## Symptomatic Patients

- Not all have a DVT, rate of demonstrable M-T syndrome in patients with symptoms in the left leg without DVT is poorly understood, but is probably greater than reported
- 20% people have M-T syndrome (≥ 50% stenosis) LLE DVT seen in 1-2/thousand/year, 0.1-2%, but M-T syn wo DVT more common, probably 1-2%/year, but is frequently overlooked
- Patients with chronic Left Leg pain ± swelling, and unilateral varicose veins, vulvar varices, pelvic congestion syndrome



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## Left leg DVT

- IVCS seen in ≥ 50% Left Leg DVT
- Left leg DVT is 6-8 X more common than right leg DVT
- Only demonstrable reason for this difference is May-Thurner Syndrome
- If see IVCS following successful lysis should you stent
- Controversial, stenting leads to potential problems



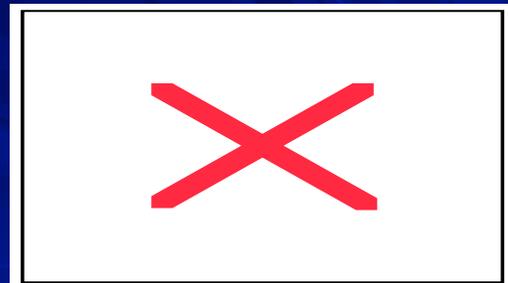
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## When to place M-T stent

- Provoked DVT, highly likely to immediately recur
- Severe stenosis in unprovoked patient, particularly if tempo of flow through collaterals is poor
- Anyone with a recurrent DVT
- What about IVUS?
- Is there a cut-off, no, but vein diameter ≤ 2-3mm?
- What if compliance with anticoagulation likely to be poor?



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## ATTRACT

- The trial provided answers, not necessarily what was expected or desired!
- Essentially NO difference in outcomes, with regard to the development of PTS at 2 years, between the 2 groups, except that major bleeding complications were more common in the intervention group
- This result, from a well controlled, rigorous study, is very disappointing in that it would suggest that interventions for DVT are, if anything, dangerous
- However, we know, from first hand experience, for over 26 years, that this is simply not true



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## Other recent studies

- Main reference study was recently published in the Lancet in December 2011, the CaVenT study
- 209 Norwegian patients randomized to conventional treatment versus CDT
- Slight reduction in the incidence of PTS at 24 months in those undergoing CDT, 37/90 Vs 55/99,  $p=0.047$
- Not as impressive as expected, but still significant
- No mechanical adjunctive therapies used at time of initiation of lysis, and the clot was up to 21 days old



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## So what are we to make of this?

- Sub-set analysis of the ATTRACT trial “suggest” that the data shows patients with above the groin DVT with moderate to severe symptoms will do well with intervention
- This makes sense, and is what we would expect, and leaves us with a pathway
- Basically, patients with below the groin DVT with mild symptoms are safer treated with anticoagulation, patients with above the groin disease and moderate symptoms should be offered intervention



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## Pathogenesis of venous thrombosis

- DVT usually arises in the calf veins
- Without treatment at this stage approx 20 % extend into the proximal venous system
- Untreated proximal DVT 10 % incidence of fatal PE, 50 % incidence of PE, and 50 % rate of recurrent DVT leading to post-phlebitic syndrome
- With treatment rate of PE decreases to < 5 %
- Incidence of post-phlebitic syndrome as determined by valvular insufficiency on Doppler approaches 50 %, symptomatic incidence ??  
Kakkar, Lancet 1969; Hull, NEJM 1979; Hirsh, Chest 1992



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## Thrombolysis

- Thrombolytic agents have been available for about 30 years, but still not widely used to treat DVT
- Problem has been fear of hemorrhage, including devastating intracranial bleeds, immunologic complications, and partially lysed emboli causing massive PE
- The initial studies which engendered these fears used systemic infusion of high doses of lytic agents
- All modern regimes use catheter-directed therapy and much lower doses, or with lytic isolation, Trellis™



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## Patient selection for CDT

- All patients have symptomatic iliofemoral DVT
- Symptoms range from pain and swelling to frank phlegmasia
- Extent of DVT is documented by Doppler
- Patients are excluded if they have contraindication to anticoagulation: bleeding dyscrasias, pregnancy or recent delivery, cerebral metastases or recent hemorrhagic stroke, < 7 days post major surgery
- Certain patients may still qualify for either mechanical thrombolysis or primary stenting



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## Massive Acute DVT (Phlegmasia)

- Painful edema of the limb
- Can lead to venous gangrene and compartment syndrome
- Phlegmasia is a surgical or interventional emergency<sup>38</sup>



## Occluded external iliac vein



## Progression of untreated phlegmasia

### DVT Timeline



## Phlegmasia "milk leg syndrome"

phlegmasia (fleg-mázi-ah)  
[G. fr. *phlegma*: inflammation]



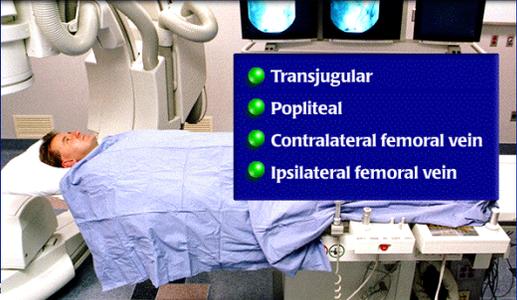
## Post-phlebotic syndrome

This is what you are trying to avoid, but it is difficult to get this across to the referring physicians, it is so much easier and "less risky" for them to anticoagulate and forget about the patient

Symptoms range from mild leg heaviness, to venous claudication, and eventually to chronic venous stasis leading to ulceration and discoloration



### Venous Access Strategies



- Transjugular
- Popliteal
- Contralateral femoral vein
- Ipsilateral femoral vein

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### Venous Access Strategies

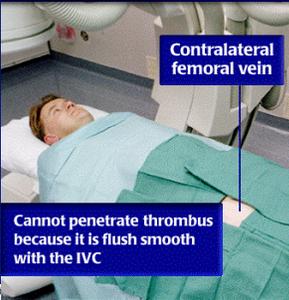


Ipsilateral femoral vein

Ipsilateral entry does not allow for lysing of thrombus below the groin

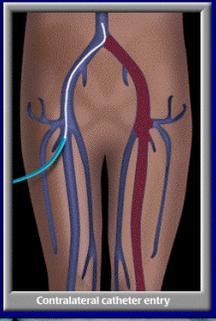
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### Venous Access Strategies



Contralateral femoral vein

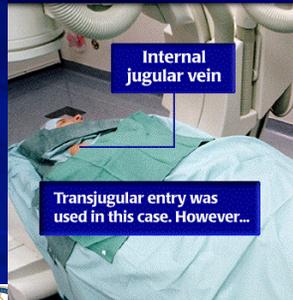
Cannot penetrate thrombus because it is flush smooth with the IVC



Contralateral catheter entry

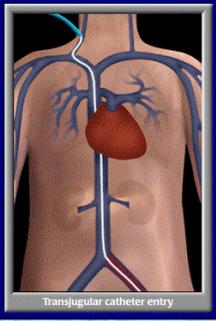
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### Venous Access Strategies



Internal jugular vein

Transjugular entry was used in this case. However...

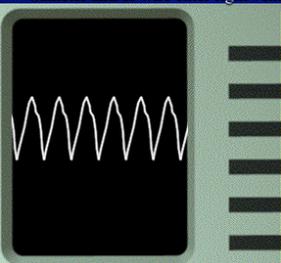
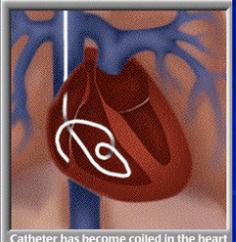


Transjugular catheter entry

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### Jugular vein access

Catheter and/or wire enter right ventricle with resultant arrhythmias

Catheter has become coiled in the heart

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### Venous Access Strategies



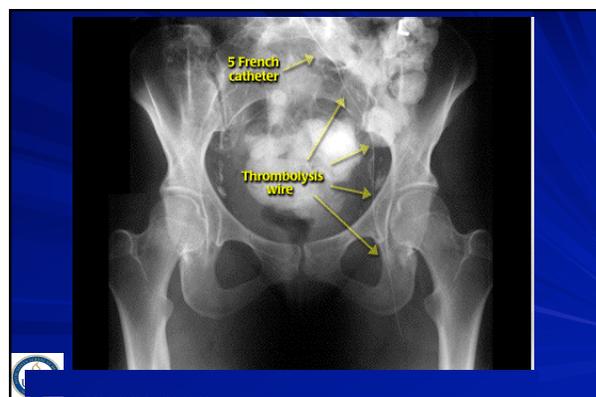
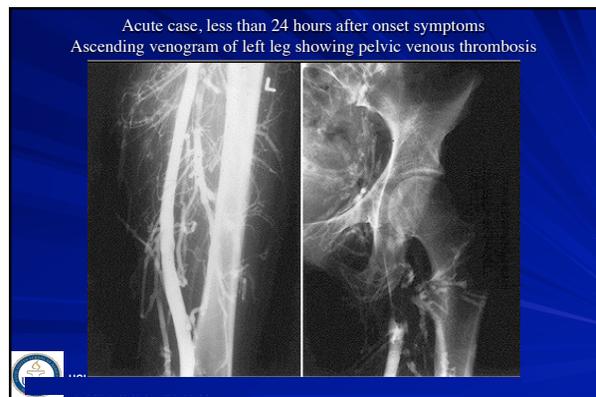
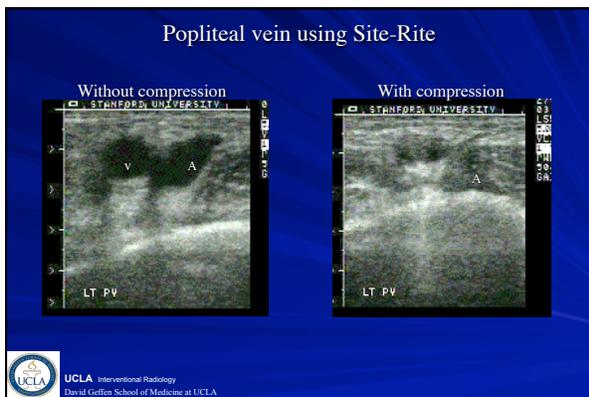
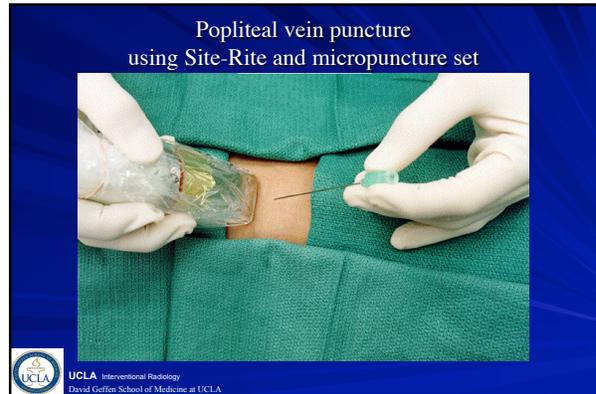
Popliteal catheter entry



Popliteal vein

The popliteal vein is our preferred point of entry for the majority of transcatheter therapy

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## Post-procedural care

Multiple i.v. pumps monitor in step-down facility

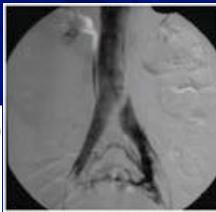


This kind of result is very much the exception, not the rule, almost never finish without using some kind of balloon and stent



Restoration of iliofemoral patency following catheter-directed thrombolysis

## May-Thurner's syndrome



Vast majority, over 80% of single leg DVT's that present to our practice are Left leg DVT's

This is likely because In the absence of M-T syndrome the clot burden rarely becomes large enough to cause symptoms despite anticoagulation



## 24 year old female on OCP with leg swelling and pain



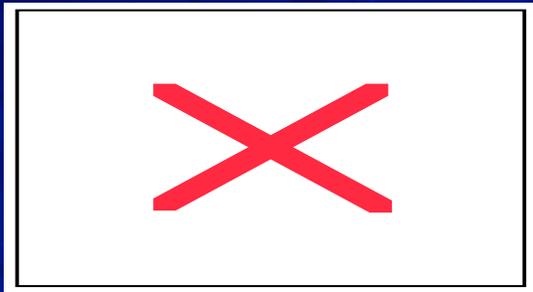
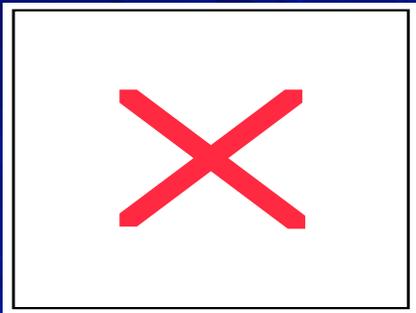
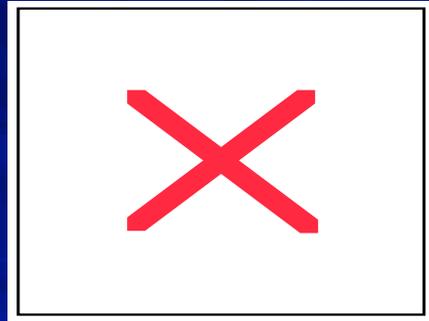
## Post lysis

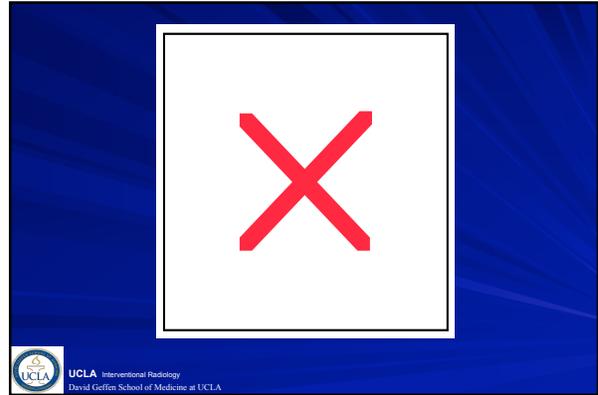
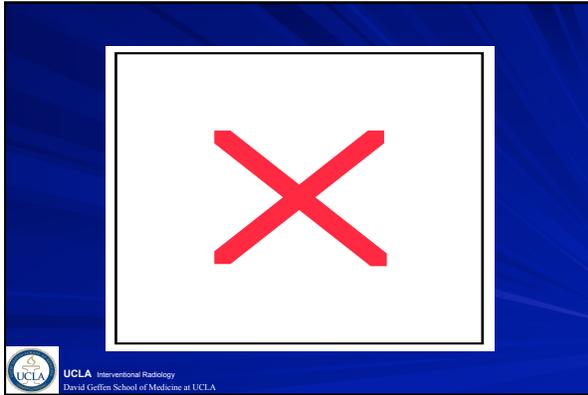


Patency restored with the exception of the proximal Common Iliac segment



New stent placed accurately





### Acute DVT

- 60 year old lady
- Ovarian CA, but systemically well
- Proven DVT on CDUS 6 weeks previously
- Failed 6 weeks worth of conventional treatment (LMWH, then Coumadin)
- Phlegmasia Cerulea Dolens

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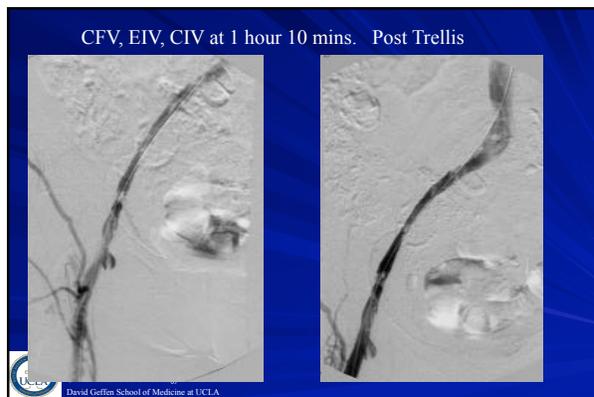


### LEFT LEG PRONE VIEWS

SFV      CFV      Iliac veins

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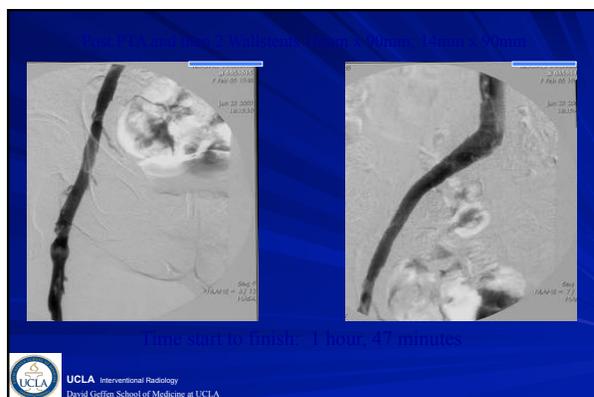




Is this as good as CDT over 3 days?

- Possibly not
- It was 6 week old clot though.....
- In any event, it doesn't matter, as the stents will be covering this area anyway

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## Successful result

- tPa largely confined to treated segment
- No need indwelling sheaths etc etc
- No need of ICU bed
- Possibly lower risk of systemic bleeding risks



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symptomatic patient is a happy patient!!!!



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35 year old lady with metastatic endometrial sarcoma, severely swollen L leg



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Prone view left leg



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- ### Adjunctive therapy
- All patients (unless contraindicated) are treated with anticoagulation for 6 months
  - Allows prevention of early recurrence, and endothelialization of stents
  - Longer anticoagulation may be required, particularly if underlying malignancy or coagulopathy
  - Nowadays will work up all patients for a variety of deficiencies, protein C and S, factor V Leiden, etc.
  - Some patients require graduation compression stockings
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- ### Chronic Fem-Pop disease
- Group of patients with extensive femoro-popliteal DVT, however, Iliac segment is completely clot free
  - No limb predilection, unless it is Post-Iliac DVT and the superior segment has completely cleared
    - This seems unlikely, however, I have seen left leg fem-pop DVT, patent Iliac, with May-Thurner anatomy!!! What to do here, coincidence, stent!
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- ### Evaluation
- The vast majority of these patients present to IR following a Duplex Ultrasound of the affected lower extremity
  - In acute DVT the thrombus is hypoechoic and expansile, however, after months the vein will scar to small size, with wall thickening, senechia, small channels of flow
  - Venous hypertension causes increased flow in superficial veins, and worsening reflux
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## Current treatments

- The only recommended treatments currently available are
- Anticoagulation, either with Coumadin or more modern “NOAC’s”
- Level 1a evidence Elastic Compression Stockings (ECS) can significantly reduce the incidence of post-thrombotic syndrome (PTS) after acute DVT (Stavros et al, Thromb Haemost 2006)
- Not much evidence to support their use in Chronic DVT, but routinely recommended



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## Other options

- Is preliminary data suggesting that Angioplasty can benefit Chronic DVT (Spencer et al, Tech in VIR, 2014; Garcia et al, Presentation at SIR 2012)
- Is definite data showing that Angioplasty with or without stenting benefits Chronic Iliac DVT (Hartung et al, J Vasc Surg 2005)
- Can we translate this to isolated Chronic Femoro-Popliteal DVT



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## Who should have this done?

- Persistent pain, swelling, ulceration
- Less appreciated symptoms include venous eczema, venous claudication, limb heaviness, aching after exercise, foot problems, and poorly healing wounds
- Patients are enrolled after “failing” conservative management, ECS, and physical therapy



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## How do you do it?

- This can be tricky when the Popliteal Vein cannot be punctured (small scarred)
- Access is probably the most difficult issue
- Can come in though the Posterior Tibial Vein at Medial Malleolus
- Other alternatives are contra-lateral groin, and jugular vein



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## Venogram

- Venography will show chronically scarred small veins
- Glidewire (stiff?) and catheter used to advance as far as possible
- Main channel is usually a straight thin, “string”
- Spin the wire to get it to find the passage, and then spin the catheter into position also
- May need to use long sheaths to stabilize while advancing



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## Plasty

- Once you reach normal Pelvic vessels place an exchange length wire
- Then use 4mm, 6mm, and 8mm balloons sequentially to dilate the vein from below to above
- Is reasonable to think about lysing, even with a chronic history, if think there may be clot
- Main technical problem is how to “fix” dissection or perforation



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## Follow-up

- It is critical that these patients have consistent anticoagulation
- Usually started on Lovenox 48 hours before treatment (if not on something already)
- ECS usually after swelling goes down
- Follow with Ultrasound at 4 weeks, and 6 months



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## Novel ideas

- EKOS, EkoSonic Endovascular System, (BTG Inc.) which uses Acoustic Pulse Thrombolysis to assist with penetration of the lytic agent into the clot, has been successfully used to improve results in patients with chronic symptoms (Garcia presentation)
- Has led to the development of a prospective, multi-center single-arm study, which will enroll 200 patients at 25 sites



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## ACCESS PTS

- All patients must have documented symptomatic DVT for at least 6 months
- No recent aggressive intervention
- Primary endpoint is change in Villalta scores at 0 and 1 month
- Secondary endpoint major bleeding, or PE
- Followed with Villalta score, Ultrasound at 1, 3, 6, 12 months



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## Not recommended

- Can be very frustrating when venoplasty of chronically occluded veins results in sub-optimal flow
- However, need to be patient
- It may take multiple treatments
- Also, this aggressive therapy causes significant venospasm
- In the infra-inguinal segment RESIST the temptation to stent



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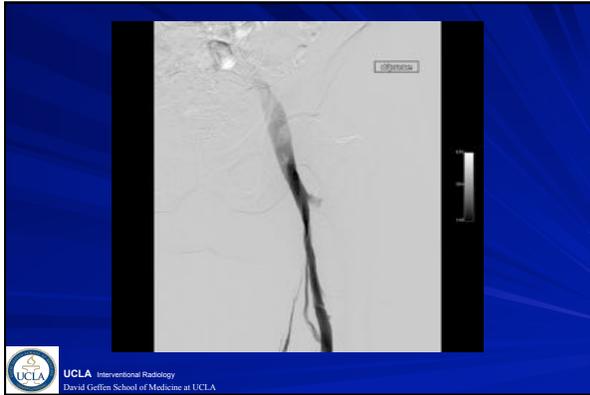
67 year old male with persistent symptoms 2 years following isolated Right Femoral Vein DVT treated with coumadin

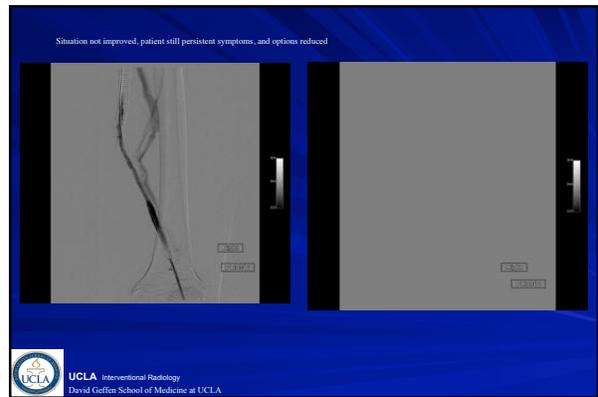
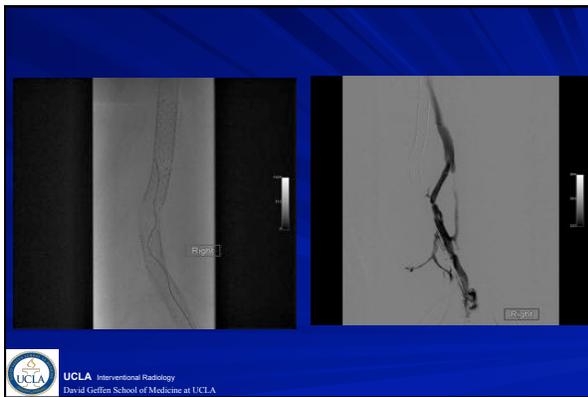
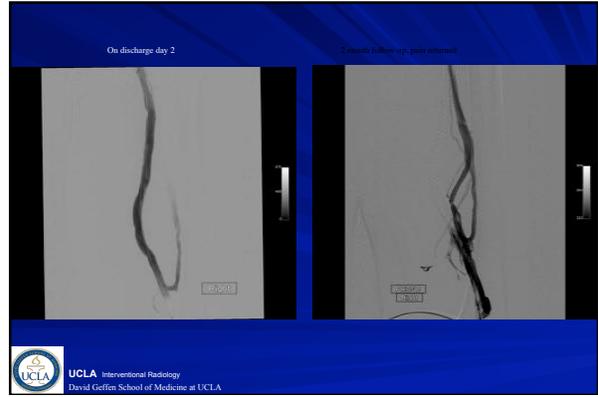


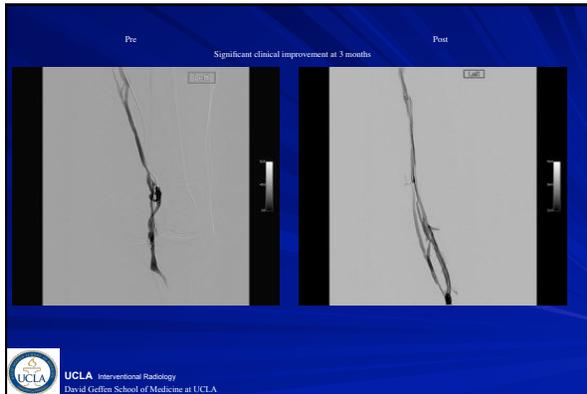
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## Conclusions

- As a subspecialty we are the only folks who understand and know how to treat venous occlusive disease
- Medicine think it understands the disease, however, when it is extensive they haven't a clue
- Anticoagulation alone is not enough
- Lysis, in the correct doses, is safe, very safe
- It must be combined with other endovascular techniques, with which we are extremely familiar
- Successful therapy has long-term benefits in a young patient population

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