VENOUS DOPPLER SONOGRAPHY OF THE EXTREMITIES

Disclosures

As you can see, I have nothing else to disclose.

There are no financial relationships to disclose.

“Longevity is a vascular question.”

Sir William Osler

MORTALITY FROM PULMONARY EMBOLUS AND OTHER CONSEQUENCES OF DVT

- 200,000 DEATHS PER YEAR FROM DVT AND IT’S CONSEQUENCES
- ANNUAL COMBINED INCIDENCE OF PE & DVT IN US: 70/100,000

American Public Health Association report 2004

SCOPE OF THE PROBLEM

- UP TO 20 MILLION CASES OF DVT/YR
- MANY ARE ASYMPTOMATIC
- MAJORITY ARE INFRAPoplITEAL
- 20-30% WILL PROPOGATE, RESULTING IN INCREASED RISK OF PE
- 30% MORTALITY IF UNTREATED
- UP TO 50% WITH DVT HAVE SILENT PE
- 90% OF PE COME FROM LOWER EXT
26,279 Ultrasound studies were performed at Vanderbilt during a 12 month period in 2010-2011. 4,274 were venous sonograms of the extremities to evaluate for DVT. DVT studies account for approximately 16% of all ultrasound exams at Vanderbilt. The average is about 12 cases per day.

OBJECTIVES

1. Discuss risk factors and compare various diagnostic tests for the diagnosis of DVT.
2. Present sonographic technique for evaluation of the extremities for deep venous thrombosis (DVT).
3. Develop an algorithm for diagnostic testing for DVT including D-dimer.

DEEP VENOUS THROMBOSIS

- Clinical diagnosis is difficult
- Risk factors are important
- Pathophysiology – anatomy
- Technique – protocols
- Acute vs. chronic DVT
- Upper extremity DVT
- A few interesting case examples
- D-Dimer and algorithm

DIAGNOSTIC TESTS FOR DVT

- Sonography
- Contrast venography (90% sensitive)
- Nuclear medicine
- MRI (MRV) - abdomen and pelvis
- Impedance plethysmography
- CT
- PET?
- D-Dimer

COMPARISON OF DIAGNOSTIC TESTS

- Sonography – 97% sensitive for DVT
- MRI (MRV) – 96% sensitive for DVT
- CT – 97% sensitive for DVT
- D-Dimer – 99% sensitive for DVT, 48% specific

DVT - CLINICAL DIAGNOSIS

- Clinical signs present in only 50%
- Acute unilateral leg swelling
- Calf asymmetry of more than 2 cm
- Risk factors are important
- Clinical evaluation is not reliable

Criado et al; Surgery 1997
Meyer et al; Ann Vasc Surg 1995
Anderson; J Vasc Tech 1989
PULMONARY EMBOLUS

- 3rd most common form of CV disease
- At autopsy, 64% have sub-clinical PE
- Only approximately 30/100 cases diagnosed

CT FROM ER IN A PATIENT WITH SHORTNESS OF BREATH

THE PROBLEM CONTINUES

- 40-70% OF PATIENTS WITH DVT WILL DEVELOP POST PLEBOTIC SYNDROME
  1. Pain
  2. Chronic swelling
  3. Soft tissue ulceration
  4. Valve injury with incompetence
  5. Venous hypertension

RISK FACTORS – THE BIG 3

- AGE OLDER THAN 75 YEARS
- PREVIOUS HISTORY OF DVT
- CANCER

Arch Intern Med.164:963-968,2004
OTHER RISK FACTORS

- Pregnancy
- Obesity
- Surgery
- Burns
- CHF
- Sepsis

MORE RISK FACTORS

- PROLONGED SITTING
- AIR OR BUS TRAVEL

26 yom duck hunter complained of pain and swelling in the left leg

RISK FACTOR SIMILARITIES

1. ENDOTHELIAL DAMAGE
2. HYPERCOAGULABLE STATE
3. VENOUS STASIS

VIRCHOW’S TRIAD
COAGULATION ACTIVATED BY AIR TRAVEL?

- 71 volunteers exposed to three conditions: 1. 8 hour plane flight; 2. 8 hours of immobilization in a cinema; 3. 8 hours of normal activity.
- Thrombin-antithrombin (TAT) levels higher after plane flight.
- D-Dimer values rose after plane flight

Rosendaal, F.; The Lancet; March 11, 2006

CT AFTER A LONG PLANE RIDE

ORIGINALLY DIAGNOSED AS PNEUMONIA

PATHOPHYSIOLOGY OF LOWER EXTREMITY DVT

- Usually begins in the calf veins
- Typically behind valve leaflets
- 40% resolve
- 40% organize
- 20% propagate
- Acute/partially occlusive tend to embolize

VALVES

- Deep and superficial
- More common in calf veins
- Direct the flow into the deep system
- Calf muscles work as a pump
- Upper extremity valves end at first rib
- Most thrombus forms under a valve leaflet

THROMBUS UNDER VALVES
THROMBUS UNDER VALVE
VALVES PARTIALLY CLOSED WITH ECHOGENIC MATERIAL UNDERNEATH (ARROWS)
VALVES NOW OPEN WITH ECHOGENICITY NOW GONE

CLOT OR SLOW FLOW?

SLOW FLOW

TECHNIQUE - PROTOCOLS
- Linear array transducer 5 – 7.5 MHZ
- Supine / decubitus / prone
- Grey scale / color Doppler / pulse Doppler
- Compression (transverse) w/wo color
- Augmentation / valsalva

THE DIFFICULT PATIENT
- Curved array transducer 2.5 – 3.5 MHZ
- Reverse Trendelenberg / Erect
- Tourniquet
- Augment non-visualized segment
- Power Doppler
- IV contrast
DO YOU IMAGE CALF VEINS?

- 5250 pts – 3 years (Hx DVT excluded)
- 84% symptomatic
- 4% adequate visualization of calf veins
- 14% had DVT
- 4.8% isolated calf vein DVT
- Rare to have DVT in anterior tibial vein

Labropoulou et al; J Vasc Surg 1999

CHRONIC VERSUS ACUTE DVT

<table>
<thead>
<tr>
<th>CHRONIC</th>
<th>ACUTE</th>
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</thead>
<tbody>
<tr>
<td>1. Brightly echogenic</td>
<td>1. Lightly echogenic</td>
</tr>
<tr>
<td>2. Rigid texture</td>
<td>2. Spongy texture</td>
</tr>
<tr>
<td>3. Well attached</td>
<td>3. Poorly attached</td>
</tr>
<tr>
<td>4. Vein contracted</td>
<td>4. Vein enlarged (if obstructed)</td>
</tr>
</tbody>
</table>
33 yom, ER complaint of pain & swelling LLE (previous VCFilter)
70 yom with acetabular fracture - ? Chronic DVT

NUCLEAR STUDY MAY BE USEFUL TO ACCESS DVT AGE

UPPER EXTREMITIES

- Prevalence of upper extremity DVT is increasing due to increase use of indwelling catheters
- 28-61% of UEDVT had indwelling catheter
- 23% thrombosis rate with PICC placement
- Pulmonary embolism present in up to 33% of patients with UEDVT (rarely fatal)
- UEDVT common in patients with cancer (40%), 2X as frequent as in patients with catheters

ADDITIONAL FACTS

- Other causes of UEDVT include “effort thrombosis” (Paget-Schroetter syndrome)
- Clinical features are nonspecific (swelling, discoloration, pain, and tenderness)
- Color Doppler sonography is the modality of choice for evaluation of UEDVT
- Sensitivity ranges from 78%-100% and specificity 82%-100%
- False positive studies are rare

TECHNIQUE

- Routine examination includes: internal jugular, brachiocephalic, subclavian, axillary, brachial, & basilic veins as well as contralateral internal jugular vein
- Use compression on all accessible veins as well as color Doppler and spectral analysis
- Use 5-7.5 MHz linear array transducer (curved in axilla)
SPECTRAL WAVEFORMS REFLECT CARDIAC CYCLE AND RESPIRATION

Chinn EE, J Ultrasound Med 24:829-838, 2005

ABNORMAL WAVE FORM

REFLECTION OF CARDIAC ACTIVITY IN PATIENT WITH CHF

DAMPENED WAVE FORMS LEFT SUBCLAVIAN VEIN

NORMAL WAVE FORM  DAMPENED WAVE FORM  ? NO THROMBUS

Patel MC. Radiology 211:579-583,1999

MEDIAL SUBCLAVIAN OCCLUSION

Patel MC. Radiology 211:579-583, 2005

PICC & ARM SWELLING
51 YOM WITH PICC

INTERNAL JUGULAR

JUGULAR THROMBUS

69 YO FEMALE WITH PICC

D-DIMER – IS IT USEFUL?

- Very sensitive for DVT (99-100%)
- Not very Specific (50%)
- False positives are common in any condition with fibrinolysis (diabetes, pregnancy, GI conditions, liver disease, heart conditions, recent surgery)
- Conclusion: A negative test is helpful, but a positive test may be misleading

34 yom with recent hernia repair
ER complaining of chest pain

- D-dimer – Positive
- Portable Chest Film – Normal
- Chest CT - Normal
- Venous Doppler US – Normal
- Cardiac Nuclear Scan – Normal
- Repeat Chest Film (PA & Lat) – Normal

Total cost of workup - $6682
ALGORITHM FOR DVT EVALUATION

HIGH RISK FOR DVT

CLINICAL SUSPICION OF DVT

AT RISK FOR FALSE + D-DIMER

ULTRASOUND

POSITIVE

D-DIMER

NEGATIVE

OR, IF STILL CONCERNED CLINICALLY

STOP

RISK FACTORS FOR DVT

PE SUSPECTED

LOW RISK FOR FALSE + D-DIMER

CT – PE PROTOCOL CT VENOGRAM ?

POSITIVE

D-DIMER

NEGATIVE

OR, IF STILL CONCERNED CLINICALLY

STOP

ALGORITHM FOR DVT EVALUATION

NO RISK FACTORS FOR DVT

D-DIMER

AT RISK FOR FALSE + D-DIMER

ULTRASOUND

POSITIVE

OR, IF STILL CONCERNED CLINICALLY

STOP

ALGORITHM FOR DVT EVALUATION

NO RISK FACTORS FOR FALSE + D-DIMER

D-DIMER

AT RISK FOR FALSE + D-DIMER

D-DIMER

STOP

PROPAGATION POPLITEAL - 6/07

42 YOM DIABETIC WITH LEFT LEG PAIN –NORMAL STUDY ON 6/07
POPLITEAL – 6/10

REPEAT STUDY THREE DAYS LATER

3 DAY COMPARISON

DAY 1

DAY 3

FEMORAL

POPLITEAL

41 YOF NSC LUNG CA – 5/10

FOLLOW-UP MAY 19
BEFORE AND LATER

SUMMARY

- DVT is very common in both lower and upper extremities
- It is difficult to diagnose clinically
- It can lead to PE which is often fatal
- Sonography is very accurate in diagnosing DVT when proper techniques are used
- Sonography remains the “Gold Standard” of diagnostic tests for DVT

TAKE HOME POINTS

- DVT IS VERY COMMON
- DIAGNOSIS IS OFTEN NOT MADE
- SONOGRAPHY REMAINS THE TEST OF CHOICE FOR DIAGNOSIS AND F/U
- PROPAGATION IS NOT INFREQUENT, SO DO NOT HESITATE TO SUGGEST REPEAT EXAM IF SUSPICION REMAINS
- 2 NEGATIVE EXAMS A WEEK APART ESSENTIALLY EXCLUDES DX OF DVT

THANK YOU!

REFERENCES