흉부외과, 명칭 변경 '재시동'…타학회 '거부감'

흉부심장혈관외과학회 추진 내부 통과…유관 학회 난색 극복 과제

[2015년 07월 27일 20시 00분]

유관 학회의 거센 반발에 부딪혀 잠시 숨고르기에 들어갔던 대한흉부외과학회가 대한흉부심장혈관외과학회로의 공식 '명칭 변경'을 다시 시도하고 있어 관심이 모아진다.

27일 학회에 따르면 회원들을 대상으로 대한흉부심장혈관외과학회로의 명칭 변경을 목표로 설문조사를 실시키로 했다.

질문 내용	답변	
병원명		
전문의수		
전공의수		
외래진료 명칭	흉부심장혈관외과	( )
	흉부외과	( )
	기타명칭	( )
외래진료 센터명칭	심혈관센터	( )
	혈관센터	( )
	심뇌혈관 센터	( )
	기타 명칭	( )
병원내 독립된 혈관외과 개설여부	없음	( )
	있음	( )
흉부외과의 혈관질환 진료여부 (정맥류, 정맥혈전증, 림프부종, 정맥부전, 폐동맥색전증, 혈관성피랭증 등)	진료함	( )
	타과 (외과, 혈관외과 등) 진료	( )
흉부외과의 혈관질환 입원여부 (정맥류, 정맥혈전증, 림프부종, 정맥부전, 폐동맥색전증, 혈관성피랭증 등)	진료함	( )
	타과 (외과, 혈관외과 등) 진료	( )
흉부외과의 혈관질환 수술여부	진료함	( )

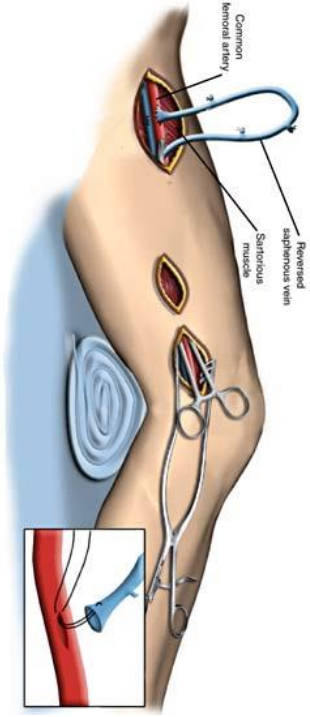
현재 대한의학회에 등록돼 있는 공식 명칭은 '대한흉부외과학회'다.

이미 흉부외과학회 내에서는 지난 2003년 11월 총회에서 '대한흉부심장혈관외과학회'로 명칭 변경이 승인돼 정관 개정이 이뤄진 바 있다.

이후 학회는 대한의학회에 수차례 명칭 변경을 신청했으나 타 유관학회 반대로 명칭 변경이 보류되고 있어 답보 상태에 머물러 있다.

그도 그럴 것이 대한혈관외과학회는 외과 전문의를 대상으로 '외과-혈관질환분과전문의'에 관한 승인을 의학회에 신청한 상황이어서 미묘한 기류가 흐르고 있기 때문이다.

1960년대 후반 외과학회에 포함돼 있던 흉부외과학회는 대학병원마다 흉부외과가 일반외과에서 독립하기 시



[B]	[처 방 내 역]	용량	단위	횟수	일수	용
	Artery Bypass(인조혈관이용)[대퇴-슬와동맥					

처방코드	00164
처 방 명	ass(인조혈관이용)[대퇴-
의 보 수 가	555,477
일 반 수 가	1,281,870

[B]	[처 방 내 역]	용량	단위	횟수	일수	용
	Lower Extremity Arteriography [흉부외과]					
	혈관내 스텐트 삽입술(기타혈관)[흉부외과용					

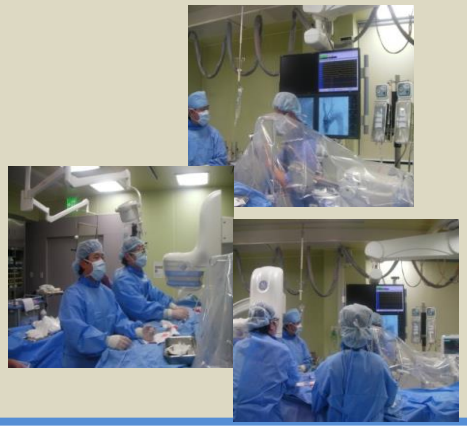
처방코드	RA149CS
처 방 명	er Extremity Arterio aphy [흉부외
의 보 수 가	354,069
일 반 수 가	819,810

처방코드	M6605CS
처 방 명	관내 스텐트 삽입술 기타혈관)[흉부외과
의 보 수 가	967,577
일 반 수 가	2,232,870

C-arm vs Cath room vs Hybrid-room

Hybrid-room

Cath-room



Operation-room

Field of Vascular Care !!

Lower Extremity Disease

- Iliac artery disease
- SFA ds – long occlusion, femoropopliteal disease
- Below the Knee

Renal, Carotid, Subclavian Artery Stenosis

Venous disease – SVC, DVT, Vein occlusion

Aorta Disease – Aortic dissection, aneurysm, AAA

Adult congenital and structural heart disease (TAVI, ASD closure, percutaneous MVP)

Deep Vein Thrombosis & Pulmonary Embolism

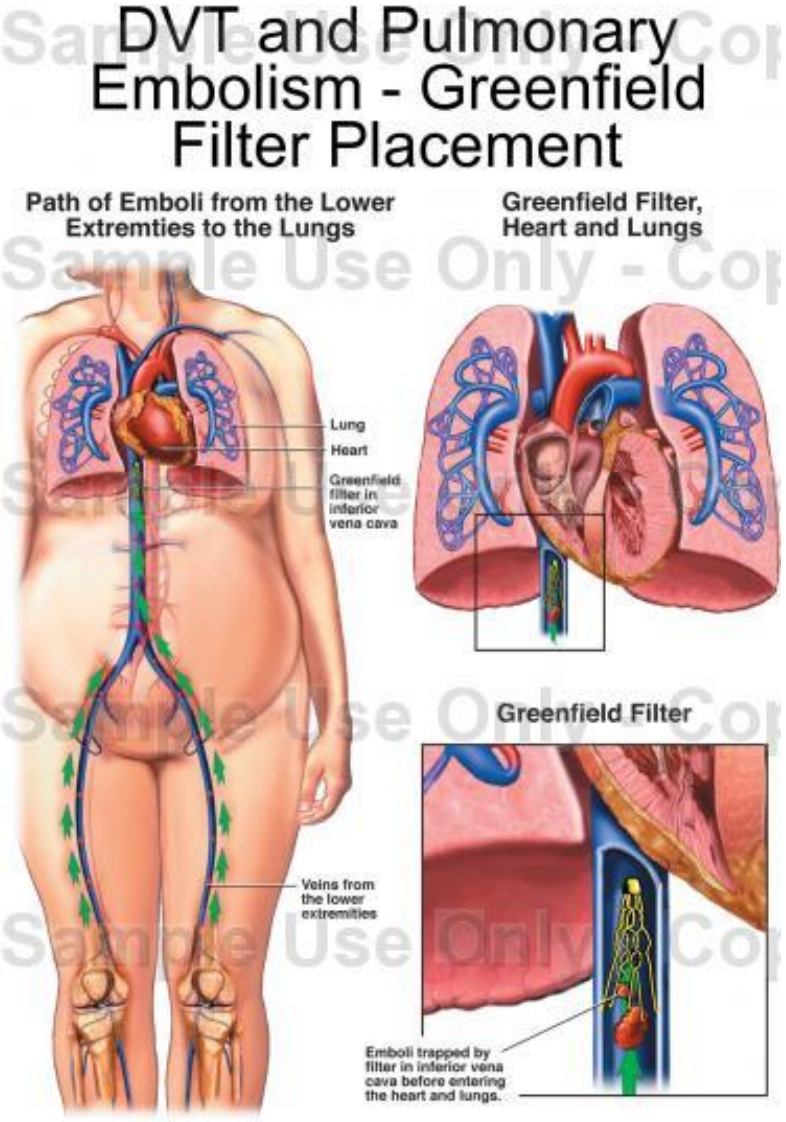
: overview & treatment

Department of Thoracic and Cardiovascular Surgery

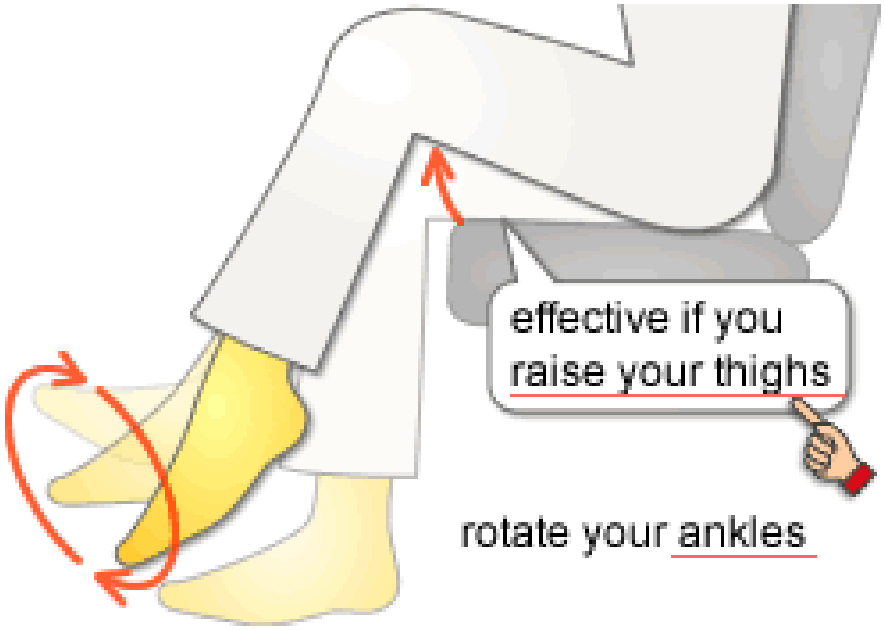
Mediplex Sejong Hostpial

Joon Hyuk Kong

심부정맥 혈전증의 위험성

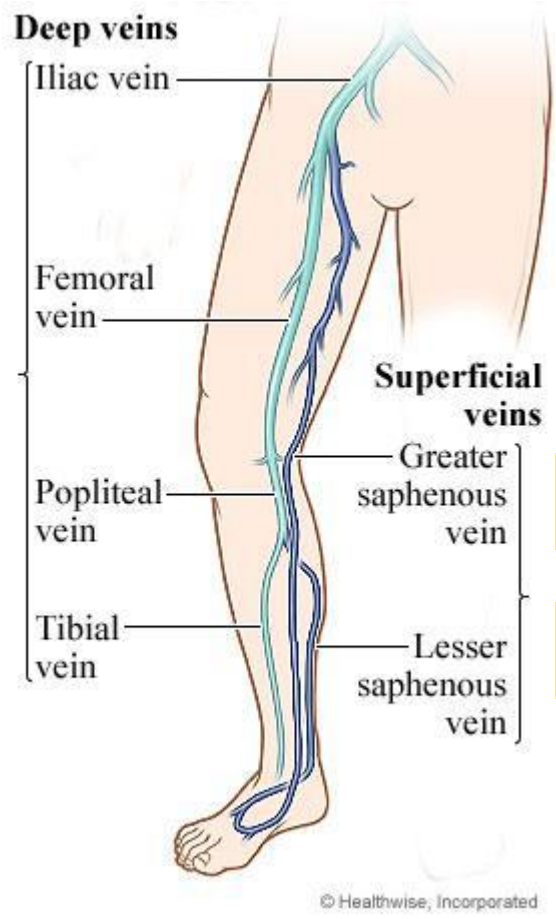


Economy class syndrome



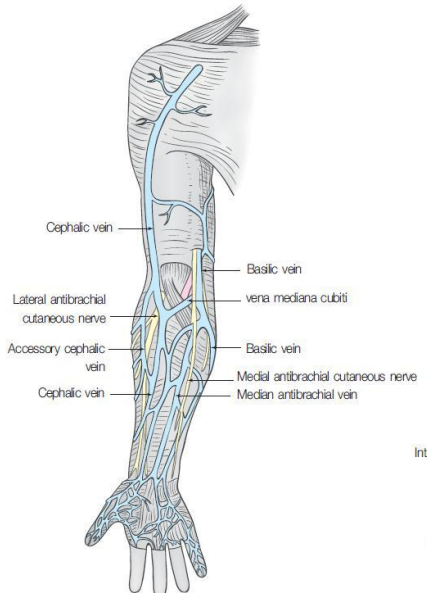
Anatomy

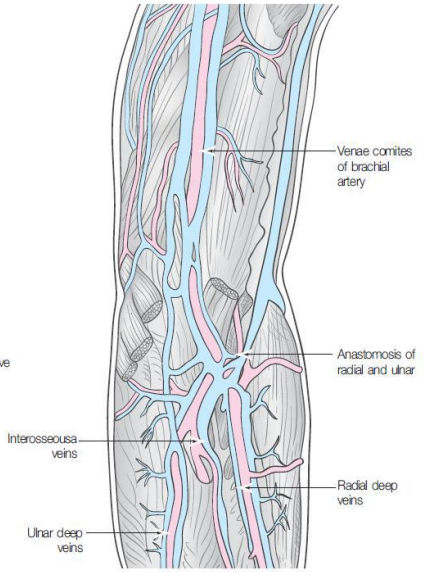
Venous System

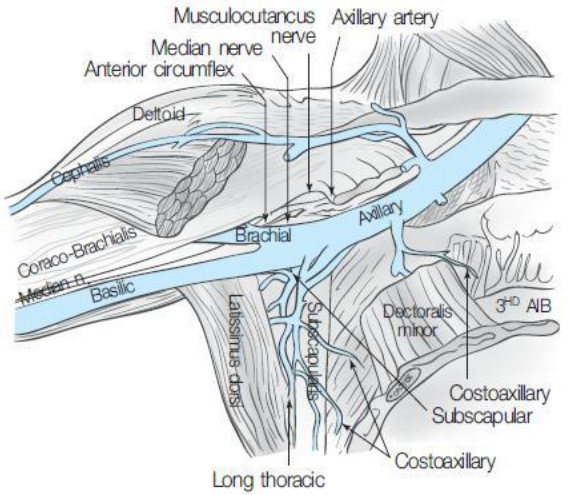


great

small

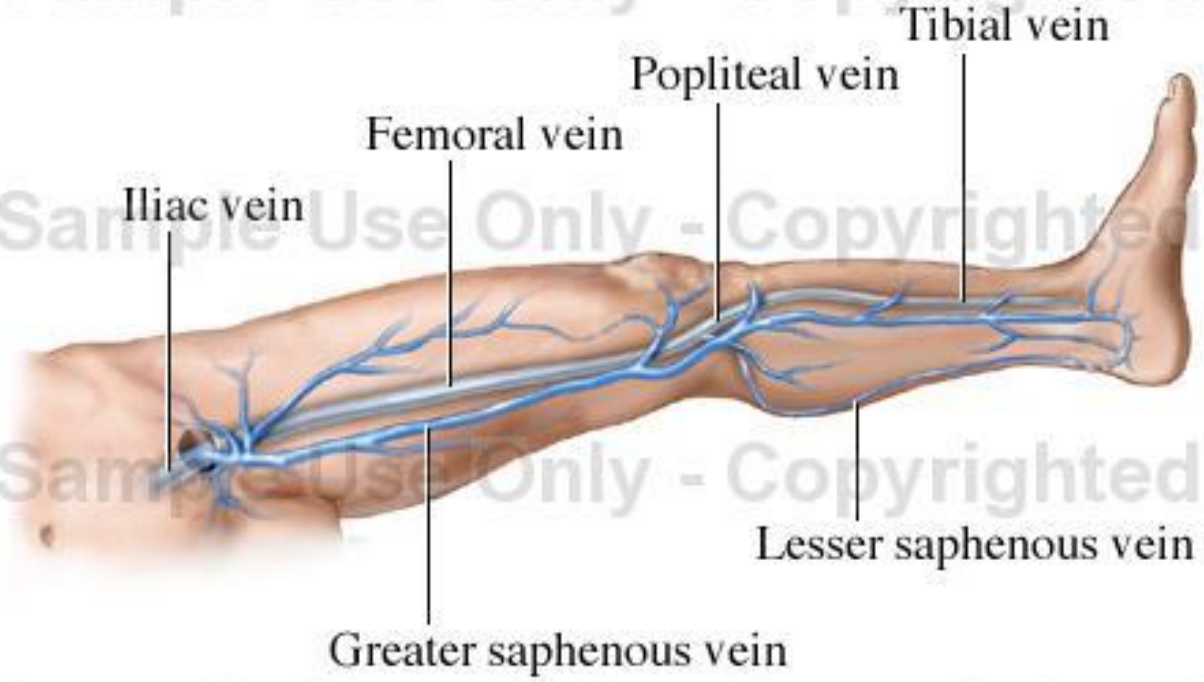




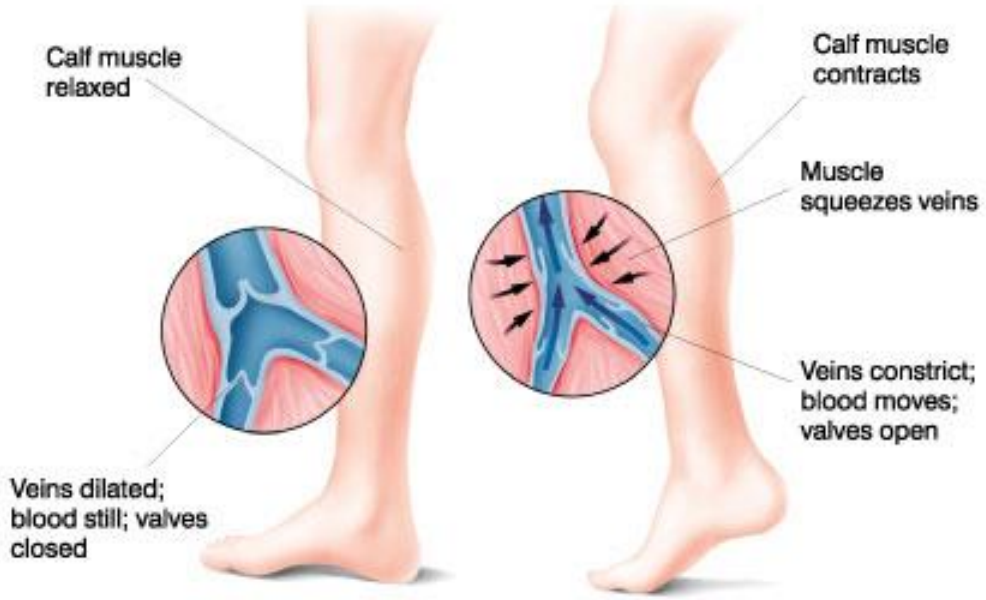


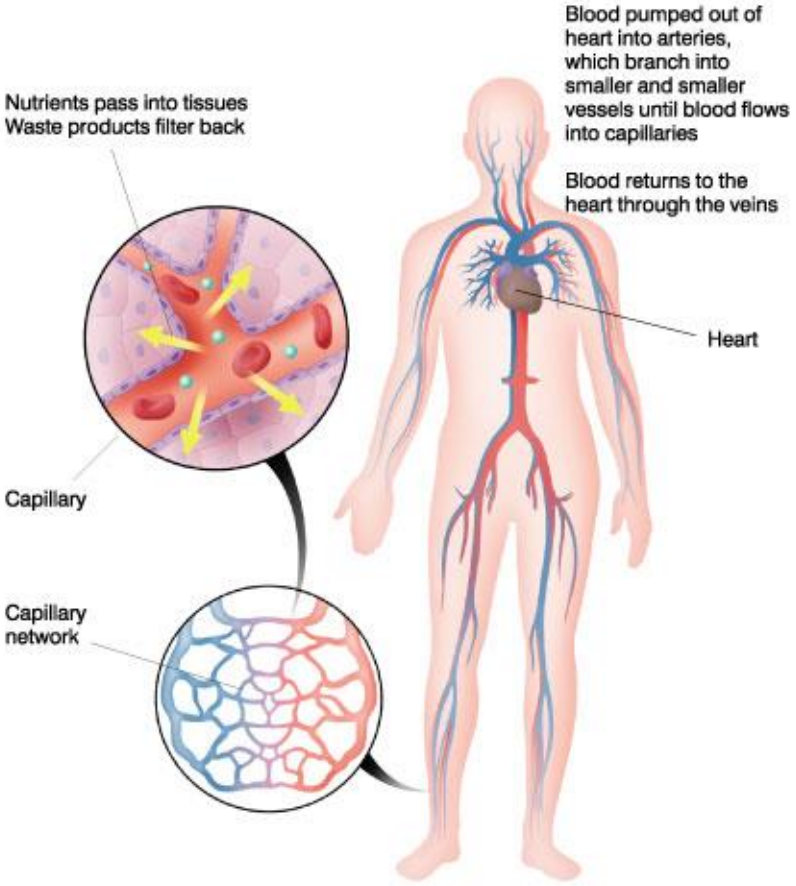
Pathophysiology

하지정맥의 구조



하지정맥의 순환


Calf muscle relaxed
Calf muscle contracts
Muscle squeezes veins
Veins constrict; blood moves; valves open
Veins dilated; blood still; valves closed


Blood pumped out of heart into arteries, which branch into smaller and smaller vessels until blood flows into capillaries
Blood returns to the heart through the veins
Nutrients pass into tissues
Waste products filter back
Heart
Capillary
Capillary network

Venous Thromboembolic Disorder

- **Deep Vein thrombosis / Pulmonary embolism**
  - Traveler's thrombosis (Economy class syndrome)
  - Chronic venous insufficiency

- Other forms of venous thrombosis
  - Superficial thrombophlebitis
  - Axillary-Subclavian thrombosis
  - Mesenteric venous thrombosis

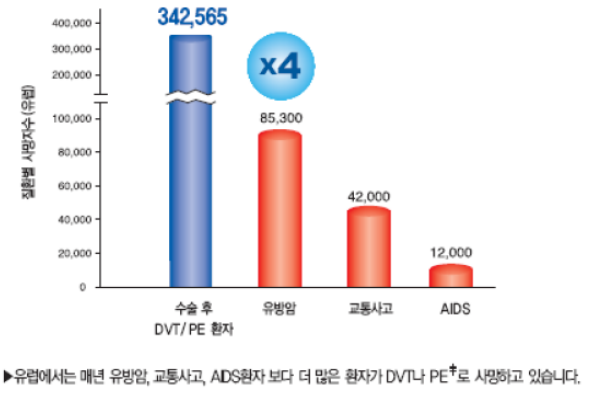
Superficial Thrombophlebitis

- Cause ; Spontaneous, Trauma, Varicose vein, Buerger's disease, Malignancy, Hypercoagulability
- Not related with bacterial infection, except caused by recent iv catheterization
- Symptoms ; localized pain, erythema, warmth, tenderness, swelling, palpable cord
- **Asymptomatic Synchronous DVT(+)** in **35%** => Check venous duplex study!
- Indication for treatment
  - Isolated superficial thrombophlebitis with encroachment on the S-F junction
  - Purulent infection
  - >5cm involvement: 45 days LMWH

Basic

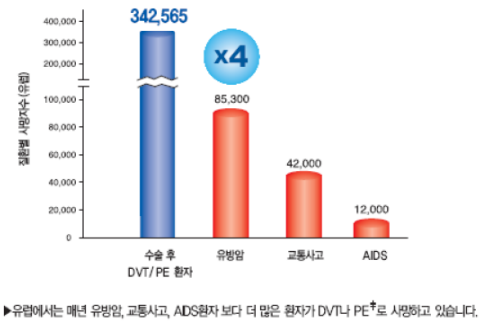
Venous Thromboembolic Disorder

- Deep Vein thrombosis / Pulmonary embolism
  - Possible cause of mortality
    - First year mortality of acute DVT ; 19-21%
    - PE death; 15% hospital death, 150,000-200,000 death/year in USA
  - Significant morbidity due to progression to chronic venous insufficiency



▶유럽에서는 매년 유방암, 교통사고, AIDS환자 보다 더 많은 환자가 DVT나 PE†로 사망하고 있습니다.

Venous Thromboembolic Disorder



- Incidence of acute DVT
  - Autopsy cases ; 35-52%
  - Community-based, venography, symptomatic ; 1.6 /1000 residents, yearly
  - Postoperative DVT; GS(19%), NS(24%), hip fracture(48%), hip arthroplasty(51%), knee arthroplasty(61%)
  - Trauma; autopsied casualties(62%), venography(58%) -- duplex(4-20%)

Epidemiology and Natural history

- The incidence of **recurrent, fatal, and non fatal VTE** has been estimated to exceed 900,000 cases annually in the united state alone.
- In the United States of America, 200,000 new cases of **pulmonary embolism(PE)** occur each year, and 50,000 of these result in death.
- **VTE** kills four to five more people annually than dose breast cancer or acquired Immunodeficiency syndrome.
- **PE** is the third most common fatal vascular disorder following coronary artery disease (CAD) and cerebrovascular accident (CVA).
- The in-hospital mortality rate is 12%, and it is thus the number one preventable death in hospitalized patients.

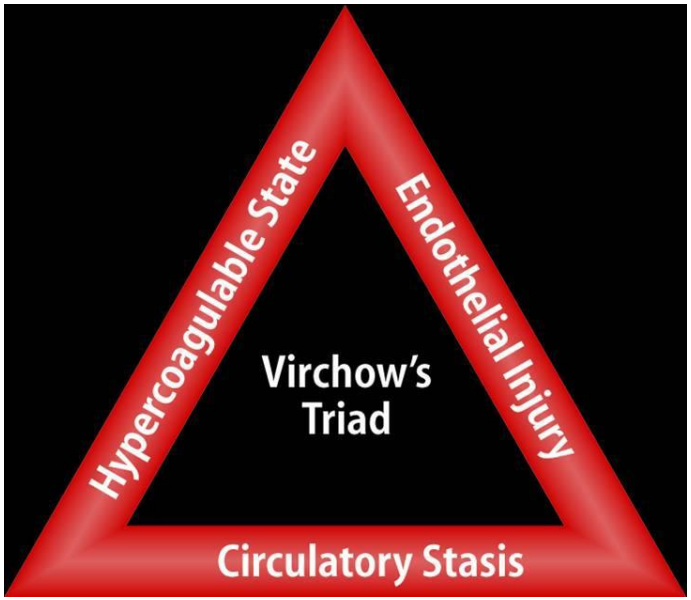
*(*Rutherford's Vascular Surgery 7th edition, section 7 venous disease, chapter 48, p 736, chapter 50 , p 770, Saunders 2010)*

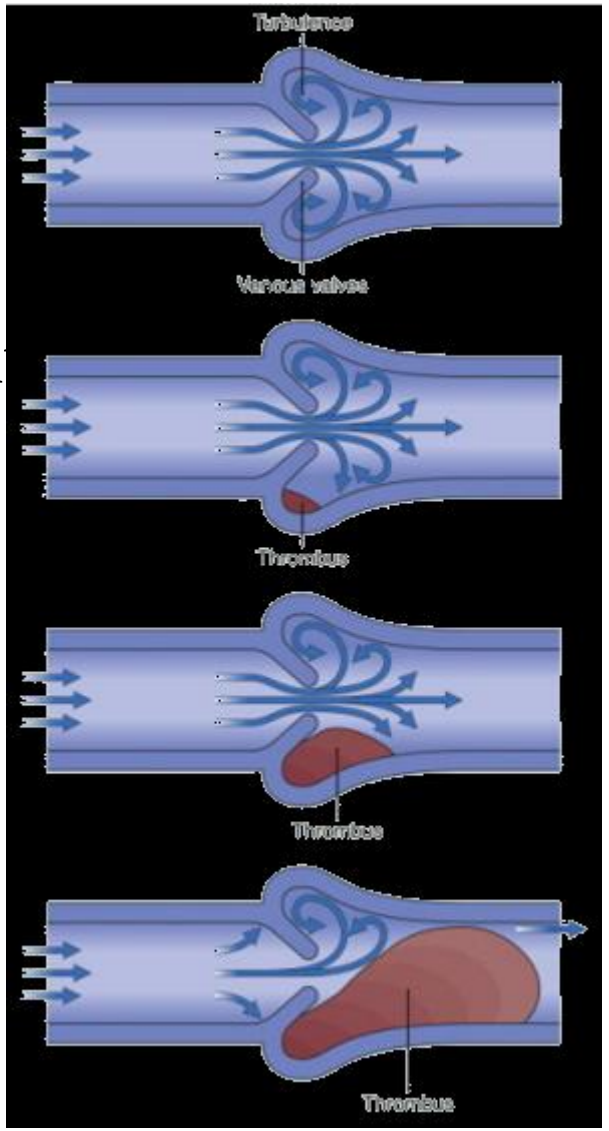
Isolated calf vein thrombosis

- Differences in
  - Rates of PE / post-thrombotic complications
- **Recanalize more rapidly**
- Lower reflux in involved calf vein segments
- Lower long term complication
  - PE : 10%, 33% by V/Q scan
  - PTS: 23% at 1yr (vs 54% in proximal DVT)
- Proximal propagation : 15% to 23%
  - in the absence of treatment
    - 1/4 - 1/3 by Kearon
- **However, Need anticoagulation !!!**

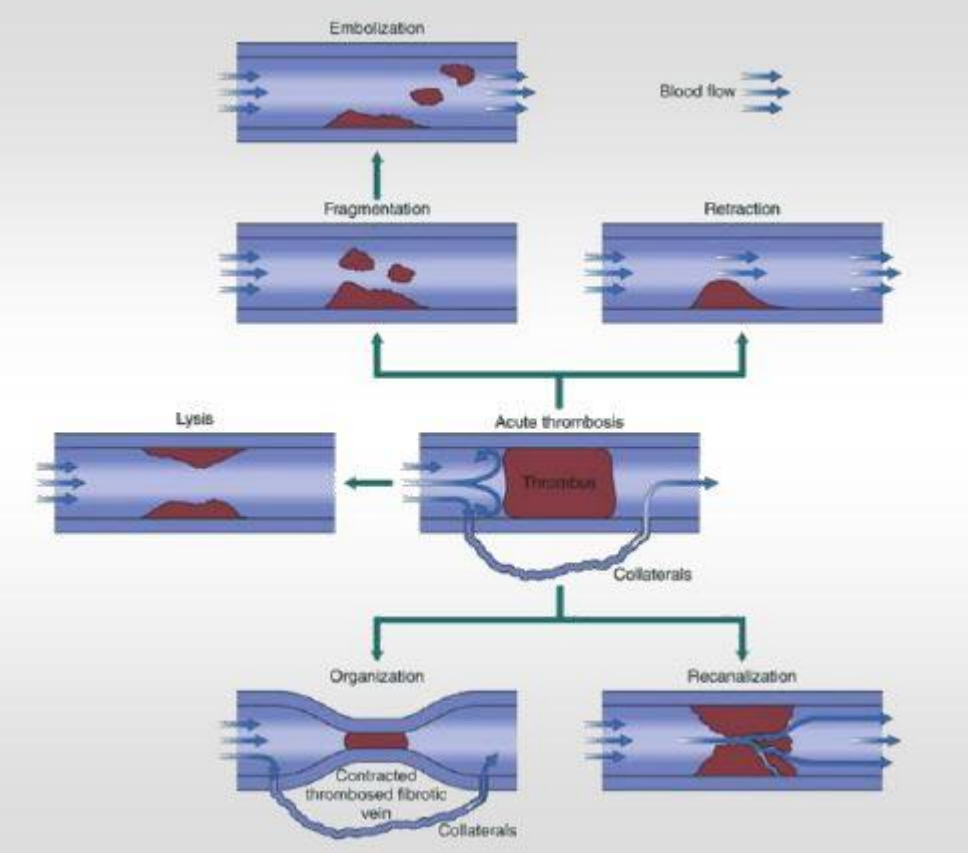
Pathophysiology

- Virchow's triad
  - Endothelial abnormality
  - Stasis of blood flow (predominan
  - Hypercoagulability of blood





Pathophysiological consequences



Clinical spectrum of acute DVT

1. Asymtomatic calf vein thrombosis
2. Symptomatic calf vein thrombosis
3. Femoropopliteal DVT
4. Phlegmasia Alba Dolens
5. Phlegmasia Cerulea Dolens
6. Venous gangrene

Clinical Course

- Acute (<2wks)
  - Flow void, low echogenic thrombus, venous distension, loss of compression
- Subacute (2-4wks)
  - Increased echogenecity, decreased venous size, resumption of flow
- Chronic (>4wks)
  - Echogenic thrombus, wall irregularity, valve abnormality, collateral veins

Clincal Course

- Acute DVT
  - Symptomless, warmness, redness, pain, swelling
- Phlegmasia alba dolens (=milk leg, white leg)
  - Increased tissue pressure exceeds the capillary perfusion pressure, causing pallor
- Phlegmasia cerulea dolens(=blue leg)
  - Deoxyhemoglobin in stagnnat vein imparts a cyanotic hue to the limb

Phlegmasia alba dolens (=white leg)

Phlegmasia cerulea dolens(=blue leg)

Risk Factors

Basic

Risk factors- hypercoagulable status

Inherited	Acquired
Common	Age
Factor V Leiden	Surgery and trauma
Prothrombin gene mutation (G20110A)	Immobilization
Homozygous C677T mutation in methylene	Malignant disease
Tetrahydrofolate reductase gene	Previous venous thromboembolism
	Pregnancy and puerperium
	Oral contraceptive
	Hormone replacement therapy
	Antiphospholipid antibodies
Rare	**Unknown (probably multifactorial)**
Antithrombin deficiency	Elevated levels of factor VIII, IX, and XI and fibrinogen
Protein S deficiency	
Protein C deficiency	
Dysfibrinogenemia	
Homozygous homocystinuria	

Basic

Acquired Risk Factors - Surgery

	Calf DVT	Proximal DVT	Fatal PE
High risk	**40-80%**	**10-30%**	**>1%**
• Surgical patients with history of venous thromboembolism			
• Major pelvic or abdominal surgery for malignancy			
• Major trauma			
• Major lower limb orthopedic surgery			
Moderate risk	**10-40%**	**1-10%**	**0.1-1%**
• Geberak surgery in patients >40 years			
• Patients on oral contraception			
• Neurosurgical patients			
Low risk	**<10%**	**<1%**	**<0.1%**
• Uncomplicated surgery in patients <40 years without any other risk factors			
• Minor surgery in patients >40 years without any other risk factors			

Acquired Risk Factors

- **Old age**
  - a major risk factor of VTE
- **Prior venous thromboembolism**
  - independent risk factor for future VTE / adequate prophylaxis
- **Immobilization**
  - 60% of the paralyzed limb / 7% contralateral normal control leg
  - air travel
- **Malignancy**
  - resulting rom activation of the cogulation cascade?
- **Superficial thrombophlebitis**
  - an independent risk factor for VTE
- **Antiphospholipid antibody syndrome**
  - anticardiolipin antibody / lupus anticoagulant antibody
  - 2% of population / 30-50% of patients with SLE
  - 50% frequency of DVT/ half having PE

Inherited Thrombophilia

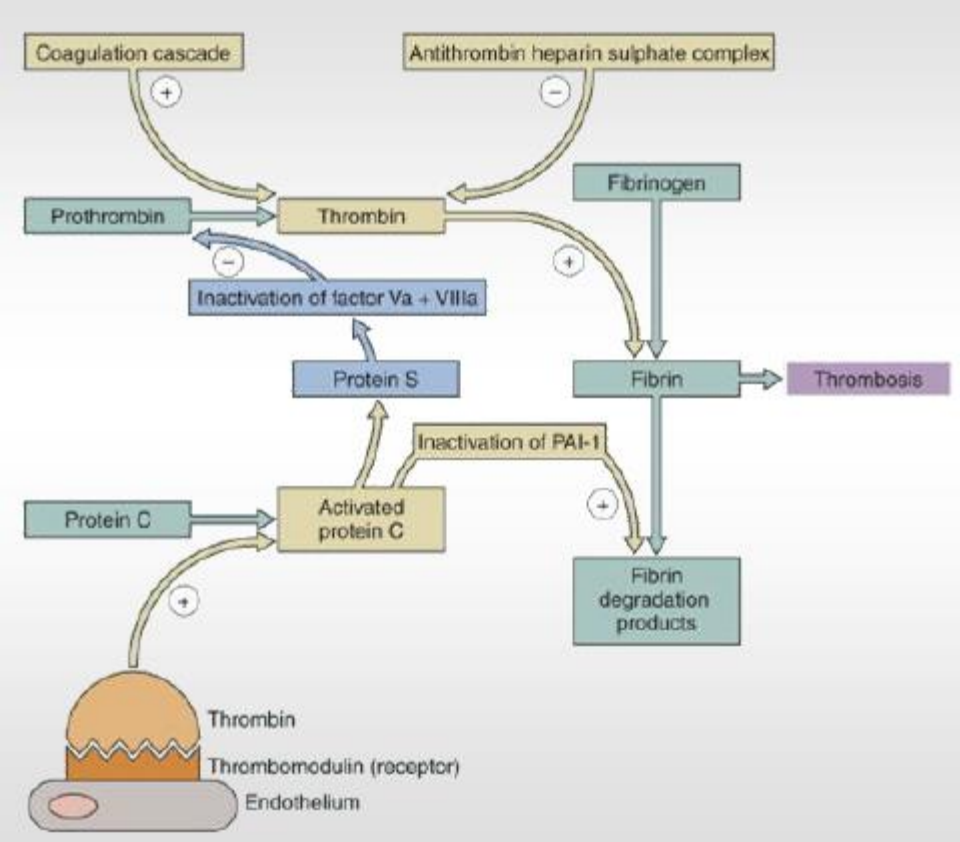
- Epidemiology

Thrombophilia	General population (%)	Patients with VTE (%)
Factor V Leiden*	5	20
Prothrombin G20210A	3	7
Elevated factor VIII**	6-8	10-15
Protein C deficiency	0.2-0.5	3
Protein S deficiency	0.2-0.5	3
Antithrombin deficiency	0.02	1
Hyperhomocysteinemia**	5	10
*Rare in the Asian and African populations		
**Likely to be multifactorial		

- Diagnosis of inherited thrombophilia
  - Should be considered in **any patient with VTE**

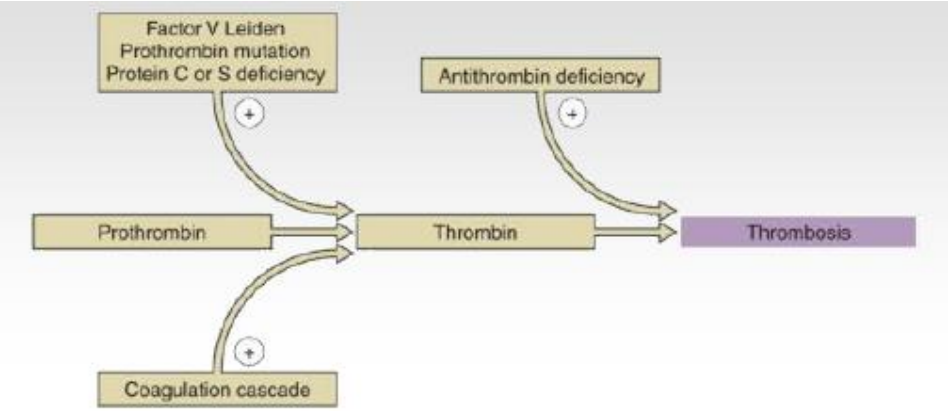
Inherited Thrombophilia

- Regulation of coagulation pathway



Inherited Thrombophilia

- Mechanism of thrombosis



- Investigation for suspected inherited thrombophilia
  - age less than 45 years
  - recurrent episodes of VTE
  - Family history of VTE
  - thrombosis at unusual venous sites such as dural sinuses
  - recurrent miscarriages

Clinical Features

Clinical Features – L/E DVT

- Mostly asymptomatic

- Pain, Edema
  - due to vein obstruction, inflammation of perivascular tissue, lymphatic obstruction
- Distention of superficial veins
- Cutaneous erythema
- Homan's sign
  - pain in calf with forced dorsiflexion of foot

Clinical Features – U/E DVT

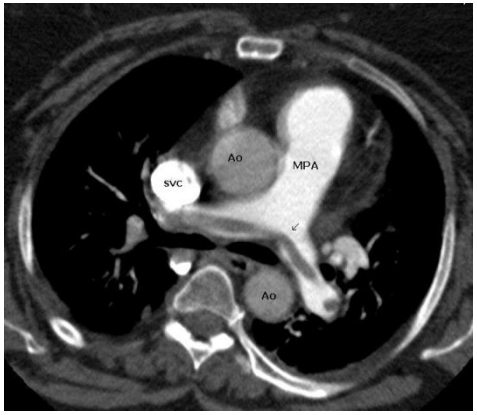
- **Less common (2-5% of population)**

- Indwelling mechanical devices
  - pacer lead, central venous catheters
  - 30-40% of cases
- Conditions of venous compression
  - lymphadenopathy, tumors
- Paget-Schroetter sndrome
- 10-30% risk for **PE** (**similar to leg DVT**)

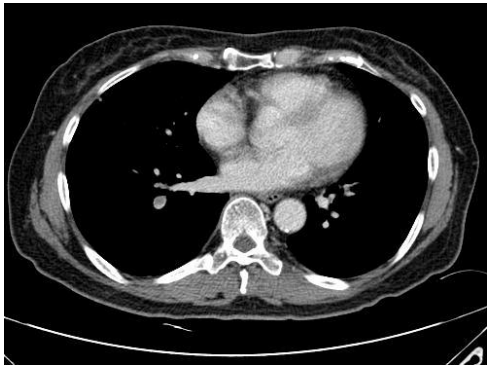
Clinical Features – PE

- Classification of PE

Pulmonary embolism	History	Pathophysiology	Therapy
Acute massive	Acute	Circulatory collapse	Thrombolysis, thrombectomy
Acute submassive	Acute	Stable, echocardio-graphic signs of RV overload	Thrombolysis?, heparin
Acute nonmassive	Acute	Stable	Heparin
CTEPH (Chronic thromboembolic pulmonary Hypertension)	Chronic	RV overload	Medical or elective thromboendartectomy

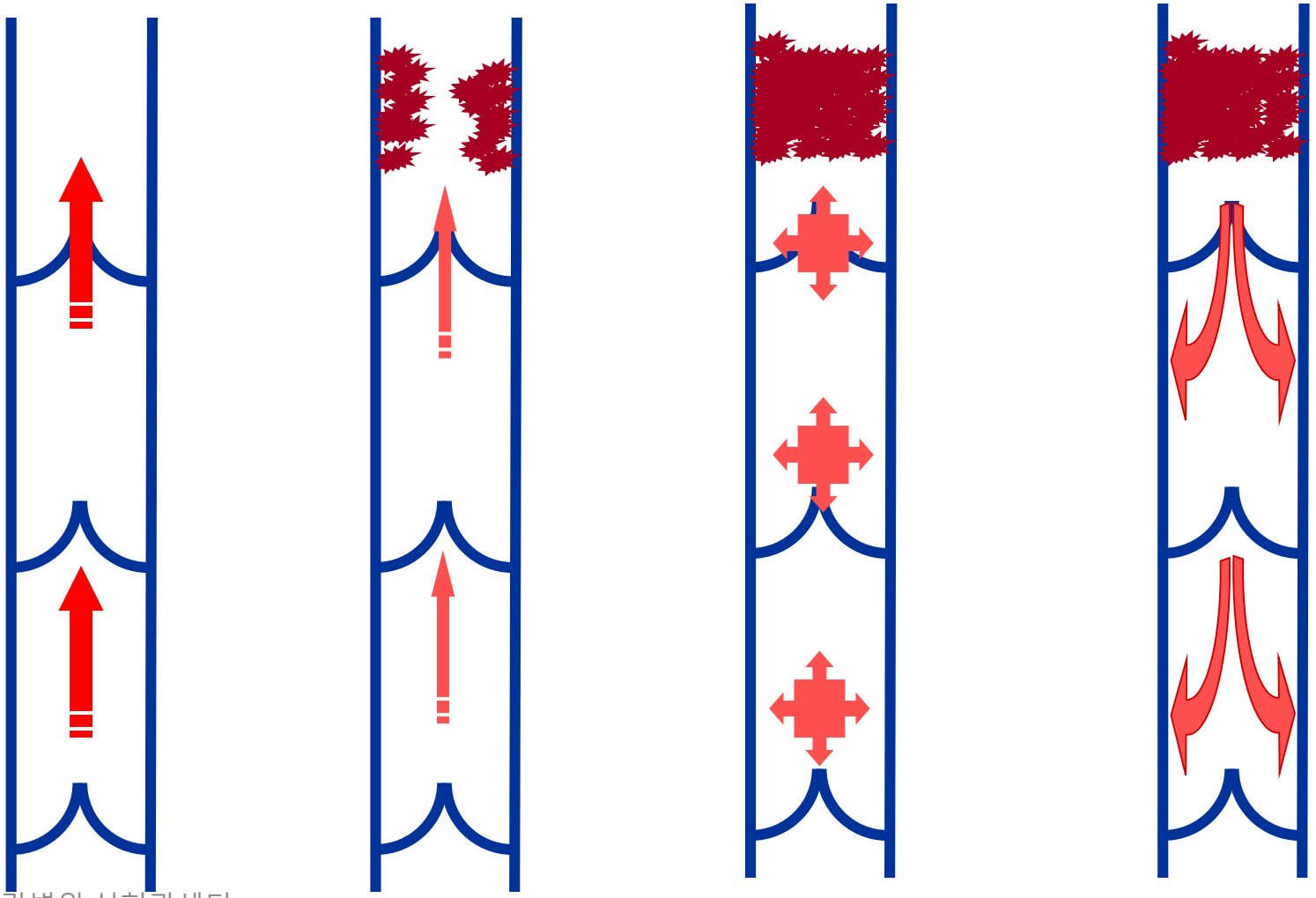


- **Acute massive**: >50% PA occlusion
  - sudden death in 10%, within 1 hr,
  - severe acute dyspnea, syncope
- **Acute submassive**
- **Acute nonmassive:** <50% PA occlusion
  - asymptomatic or tachypnea, dyspnea, pleuritic pain

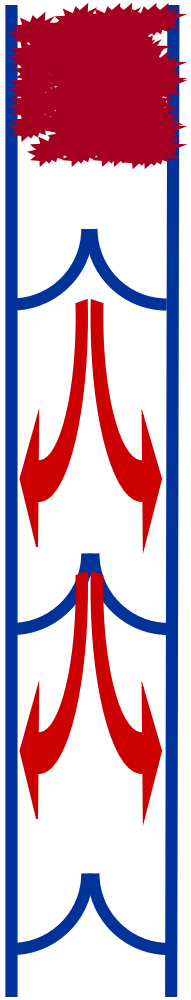


Complication

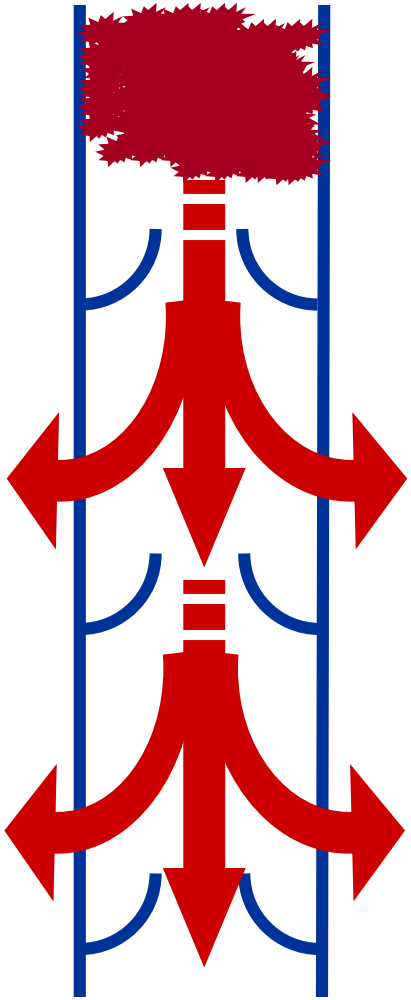
합병증 발생기전-01



합병증 발생기전-02

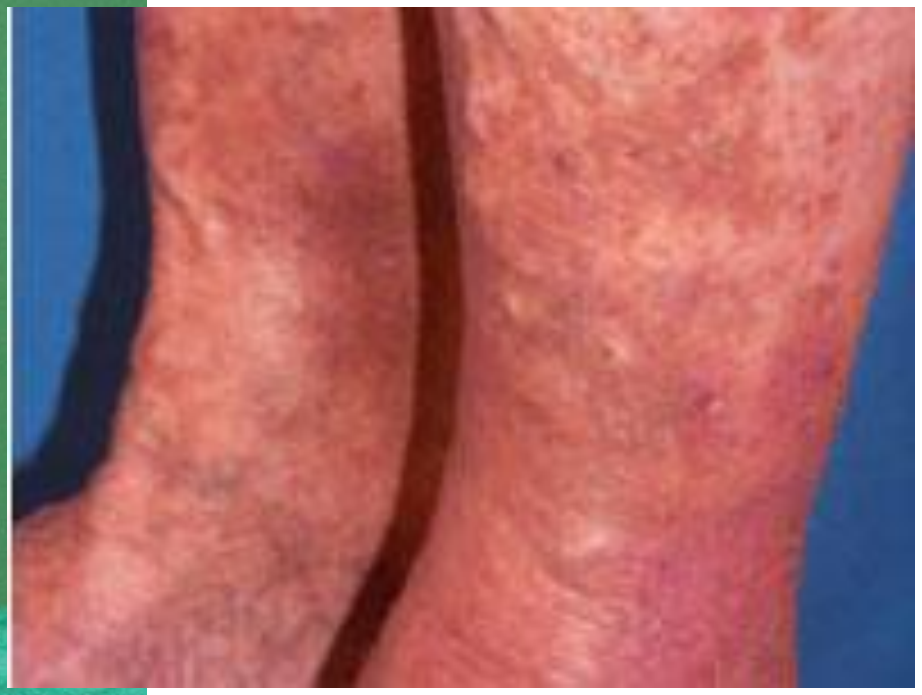


- **Venous valvular incompetence**



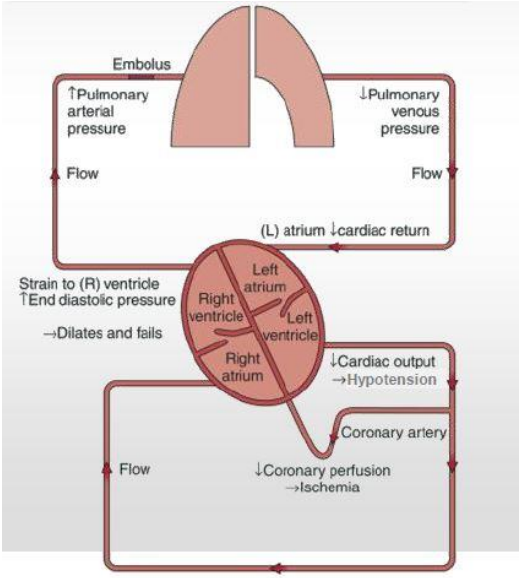
- **Post-thrombotic syndrome (PTS) symptoms**
  - Chronic leg heaviness, leg aching
  - Venous claudication,
  - Leg edema, varicosities,
  - hyperpigmentation, nonhealing ulcers
- **PTS more frequently**
  - extensive multilevel DVT
  - recurrent DVT
  - oral anticoagulant regimen was inadequate

PTS



Complications (I)

- **Pulmonary Embolism**
  - most devastating complication
    - obstruction of blood flow distal to the clot
    - rapid increase in pulmonary arterial and right heart pressure



Complications (II)

- **Pulmonary Embolism**
  - Inadequate tx. of proximal venous thrombosis
    - 20% to 50% risk of significant recurrent VTE
    - 90% of thromboemboli arising from L/Ex veins
  - Sx PE: 7% to 17% of proximal U/Ex thrombi
  - Lung scan: + in 25- 51% of Asx patients
  - Autopsy : [DVT + PE] = [1.8 X DVT alone]
  - **PE** contributes to **approx. 15% of hospital deaths**
  - 1-week survival rate after a PE : 71%
  - 25% of PE manifest as sudden death
  - Mortality in adequate Dx. and Tx.: 8% to 9%

Complications (III)

- **Post-thrombotic Syndrome**
  - less dramatic than PE
  - greater degree of chronic socioeconomic morbidity
  - 29% to 79% of patients
    - pain, edema, hyperpigmentation, or ulceration
  - Severe manifestations
  - ambulatory venous hypertension
    - valvular reflux / persistent venous obstruction / anatomic distribution of these abnormalities
  - X6 risk of post-thrombotic syndrome with recurrent DVT

Post-Thrombotic Syndrome (PTS)

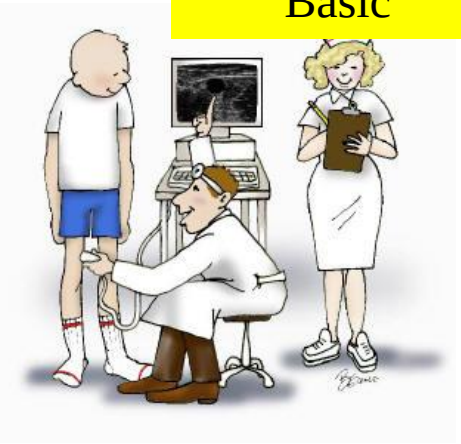
- Painfula heavy leg
- Cramps
- Paresthesia
- Prutitus
- Formation of varicosities
- Edema
- Hyperpigmentation of the skin

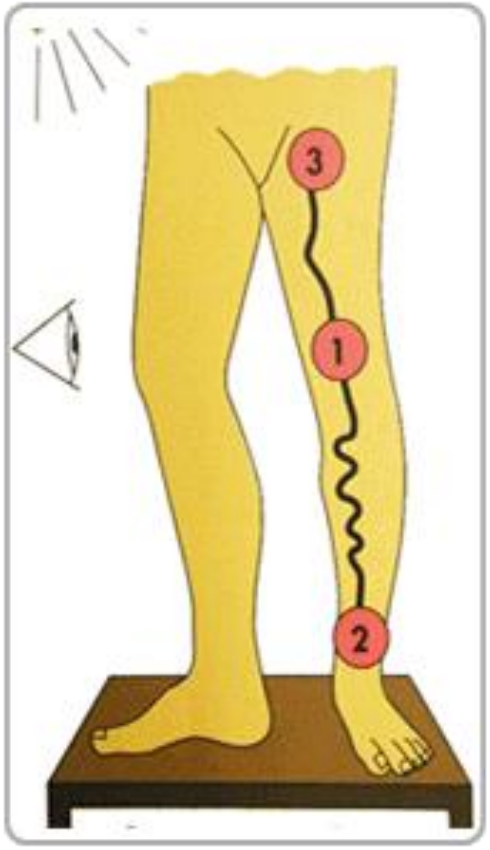
=> **Reduced quality of life (QoL)**

Diagnosis

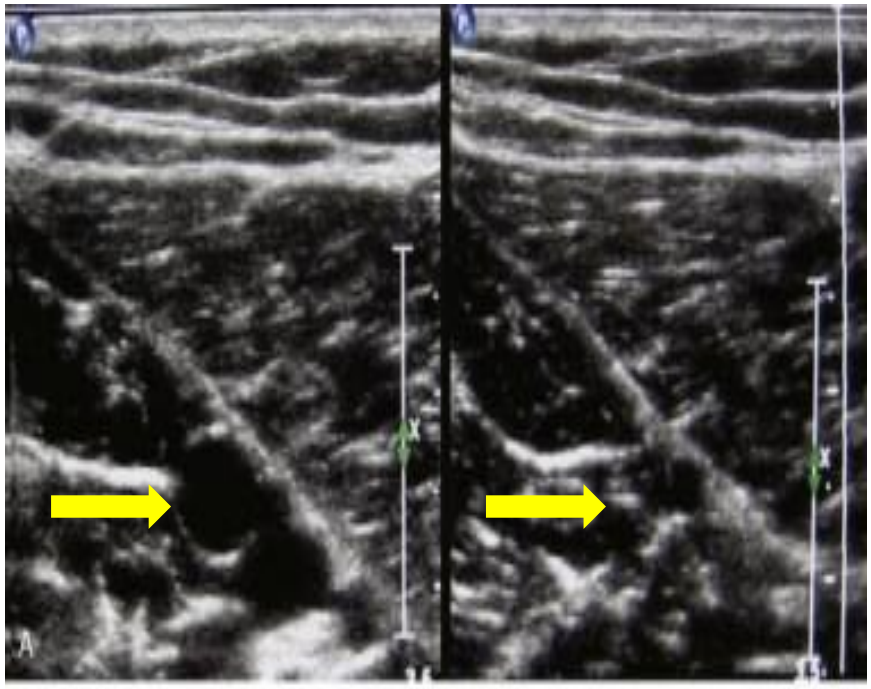
Basic

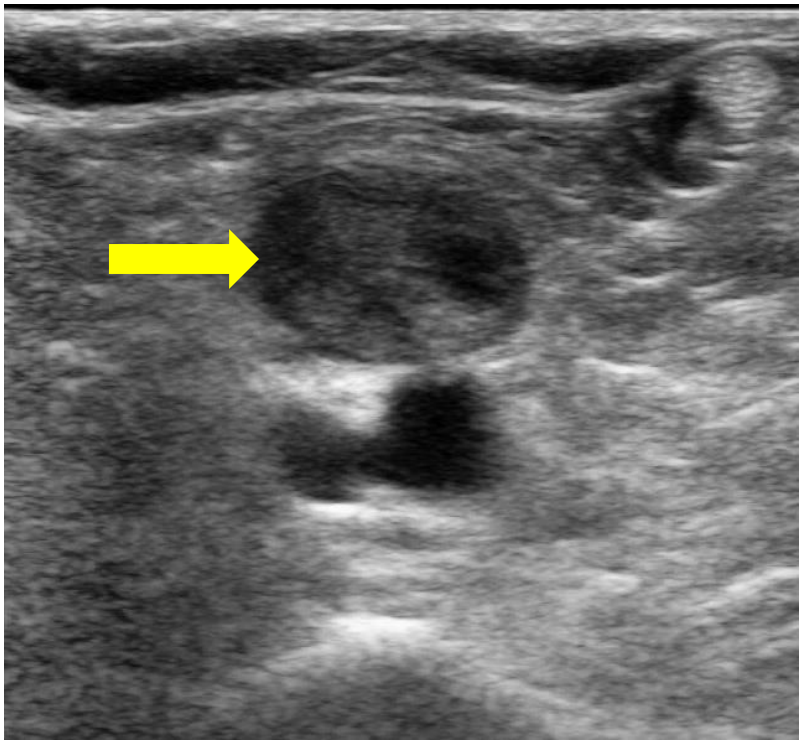
초음파검사



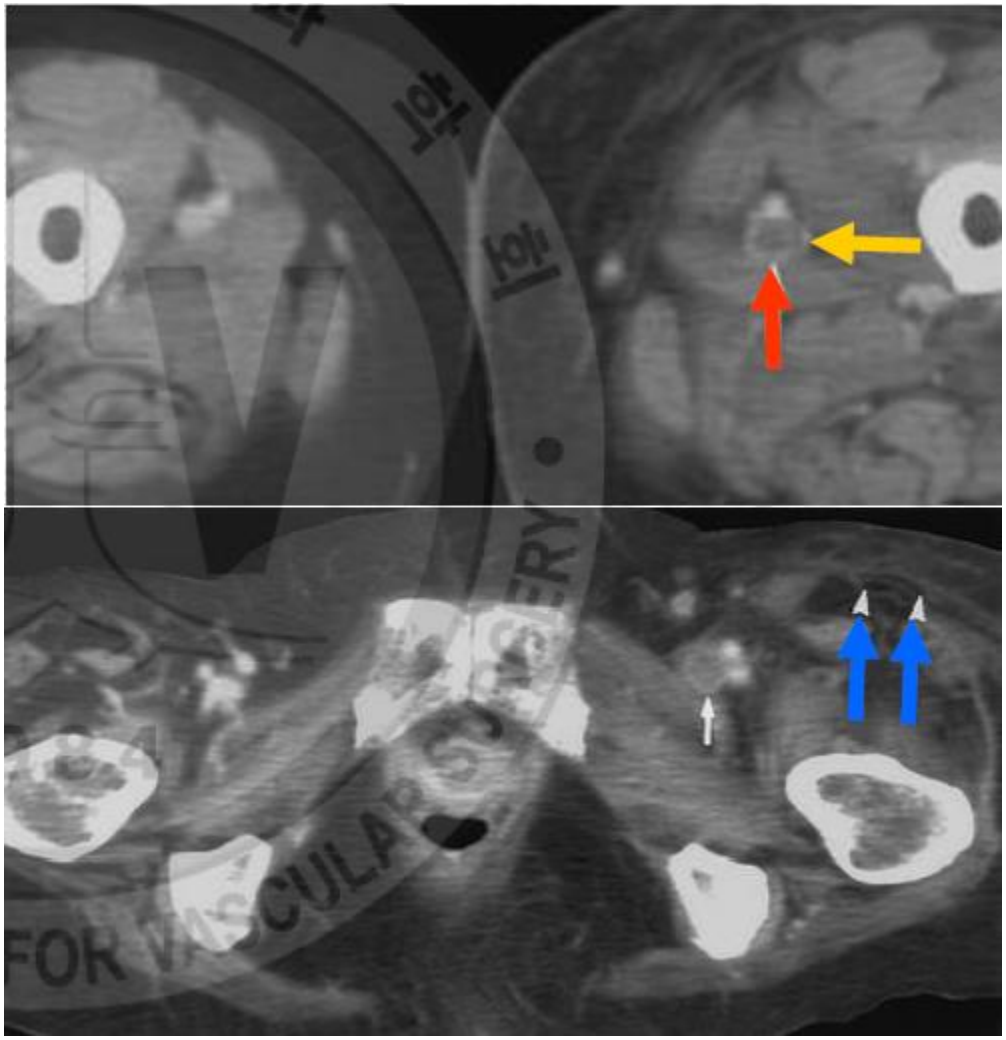


초음파검사



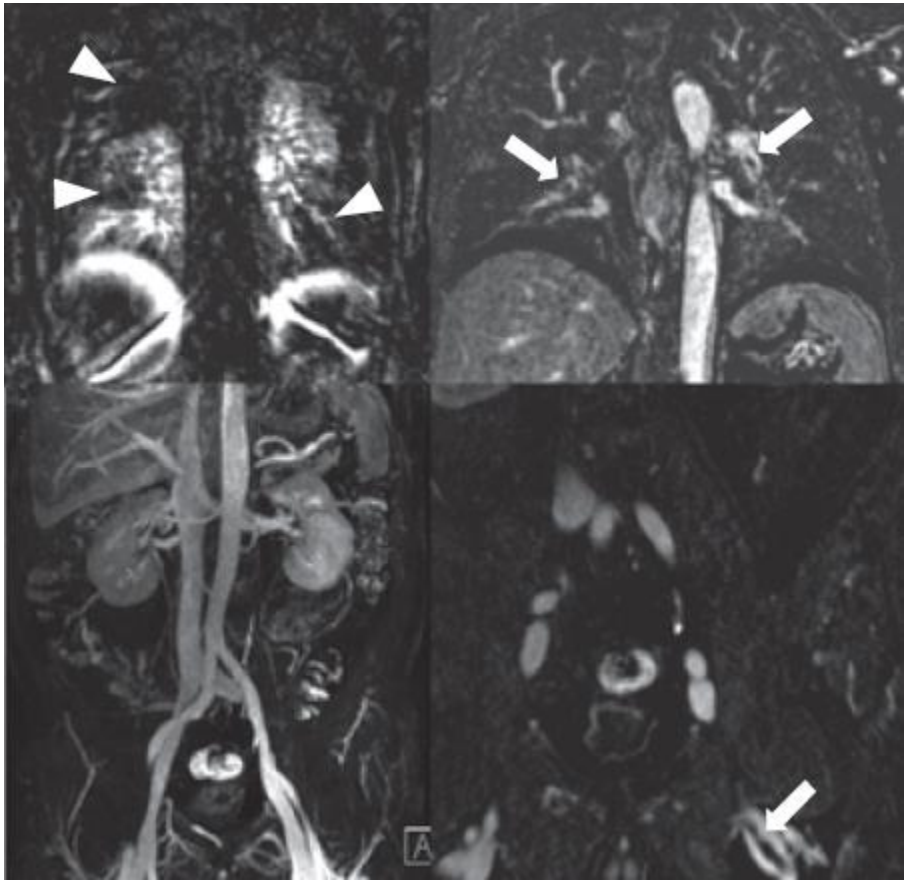


CT

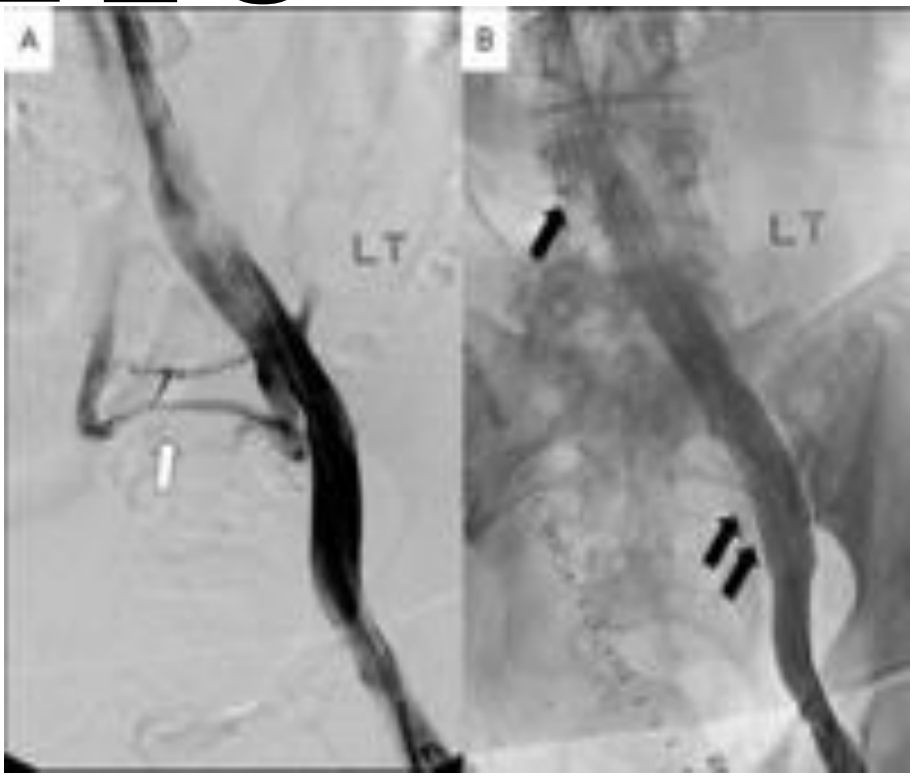


Basic

MRI



혈관촬영



Diagnosis of DVT

- **D-dimer** ; cross-linked degradation product of fibrin.
  - Sensitivity 44-72%, specificity 44-70%
  - High negative predictive value; 97-99%
- **Duplex USG** ; test of choice (Accuracy >95%)
- **CT venography** ; pelvic vein evaluation, PE study

- Impedence phlethysmography
- Ascending venography
- MR Venography
- Lung ventilation & perfusion scan

DVT ; Diagnosis

- **Before anticoagulation, Check coagulation profiles !**
  - CBC ; Hb, Hct, platelet
  - BT / PT / aPTT
  - AT-III, protein C, protein S
  - Coagulation factors VIII, IX, XI
  - Fibrinogen, FDP, D-dimer, homocysteine
  - Lupus anticoagulant, anticardiolipin Ab, antiphospholipid Ab

- **Family study in hereditary or familiar tendency**
  - Factor V Leiden, Prothrombin gene mutation ; rare in KOREA

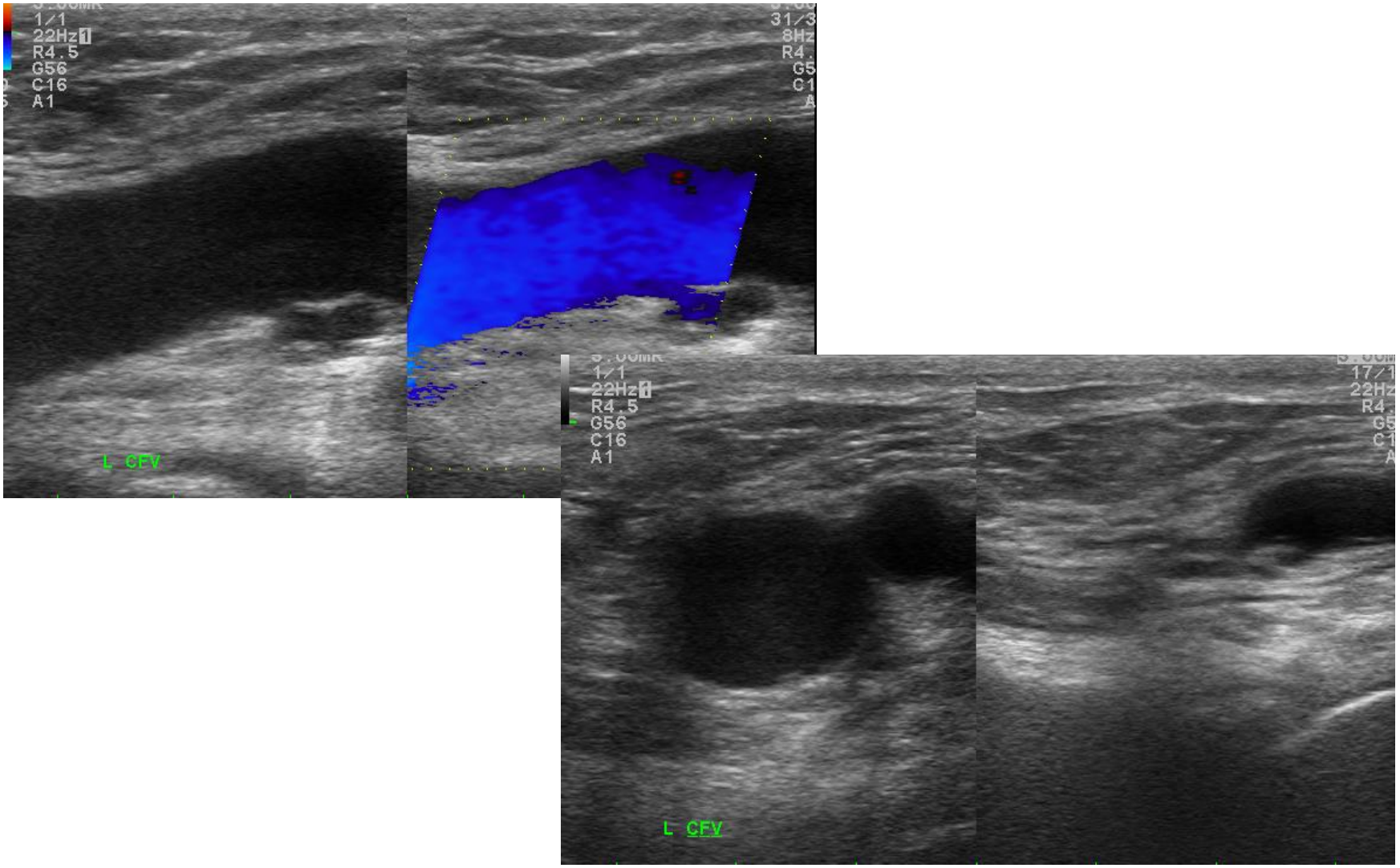
Duplex criteria for DVT

- Negative for DVT
  - Complete approximation of the vein wall during compression
  - Complete color filling of the lumen without any defect

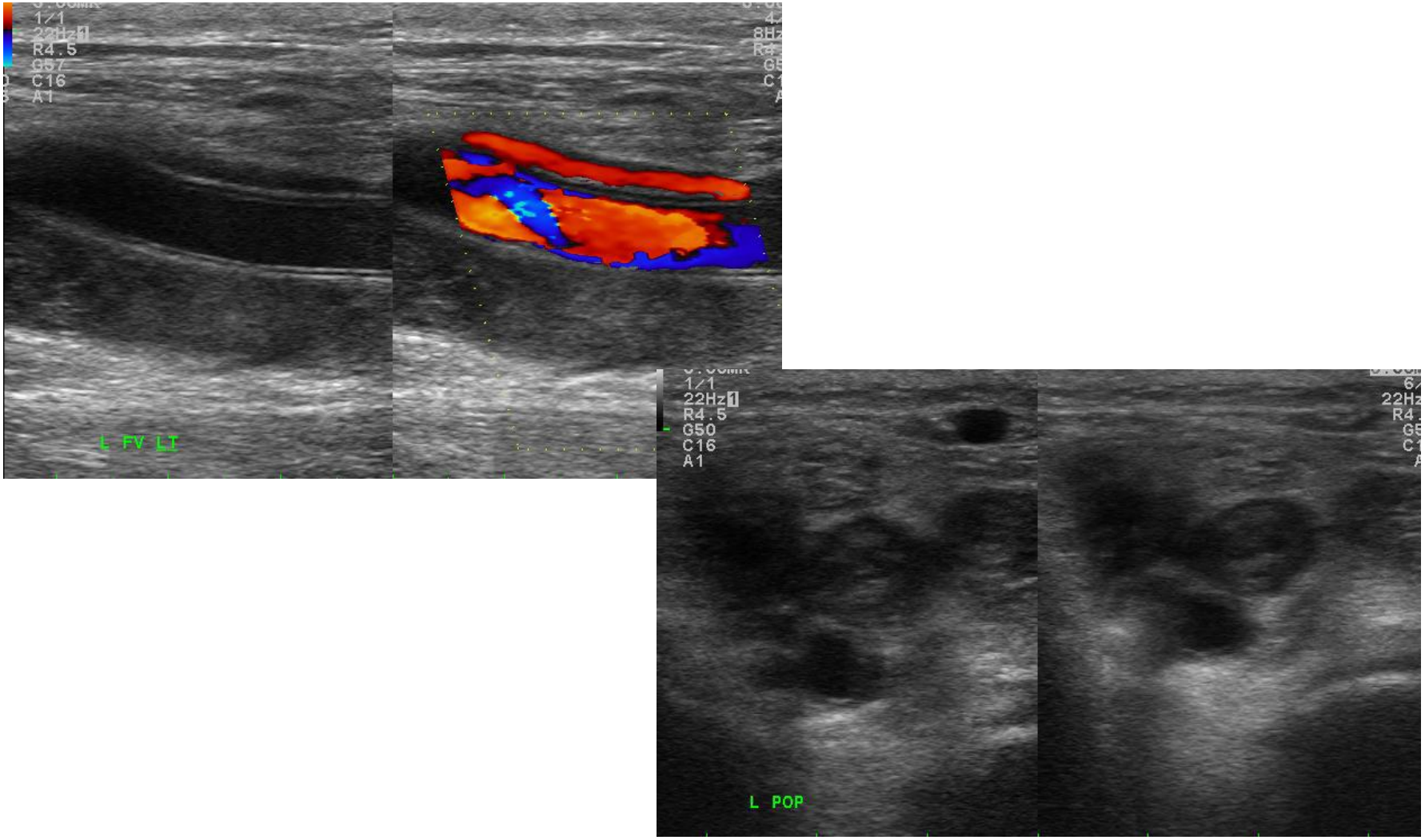
- **Positive** for DVT
  - Partially compressible or noncompressible vein
  - **Echogenic material** within the vein
  - **Filling defect** on color imaging
  - Absence of doppler signal

Mansour & Labropoulos: Vascular DIagnosis(2005)

Duplex USG ; normal finding



Duplex USG ; abnormal finding



Conditions that may mimic acute DVT

Muscle strain or blunt trauma
Ruptured muscle with subfascial hematoma
Spontaneous hemorrhage or hematoma
Ruptured synovial cysts (Baker's cysts)
Arthritis, synovitis, or myositis
Cellulitis, lymphangitis, or inflammatory lymphedema
Superficial thrombophlebitis
Arterial insufficiency
Pregnancy or oral contraceptive use
Lymphedema
Lipedema
Chronic venous insufficiency or venous reflux syndromes
Extrinsic venous compression: lymphadenopathy, tumors, lymphomas, hematomas, abscesses, right iliac artery
Systemic edema: congestive heart failure, metabolic, nephrotic syndrome, post–arterial reconstruction
Dependency or leg immobilization (casts)
Arteriovenous fistula

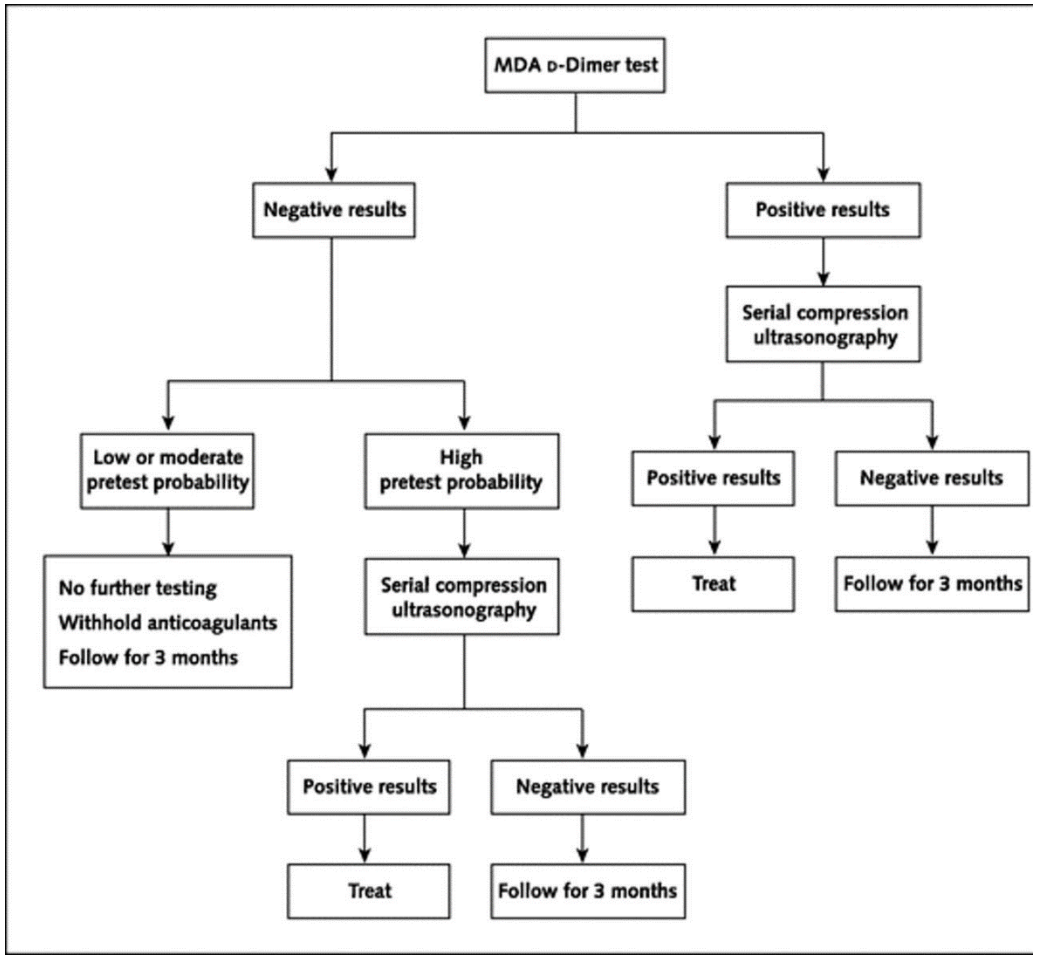
Diagnostic strategies for DVT

- Assessment of risk of venous thrombosis; **Modified Wells Criteria**

Criteria	Score
Active cancer (receiving treatment within previous 6 months or receiving palliative treatment)	1
Paralysis, paresis, or recent immobilization of lower extremity	1
Recently bedridden for ≥ 3 days, or major surgery within 12 weeks requiring any type anesthesia	1
Localized tenderness along distribution of deep venous system	1
Entire leg swollen	1
Calf swelling ≥ 3cm increased compared to asymptomatic leg (measured 10cm below tibial tuberosity)	1
Pitting edema confined to symptomatic leg	1
Collateral superficial veins (nonvaricose)	1
Previously documented DVT	1
Alternative diagnosis at least as likely as DVT	-2

Risk Assessment	Score
Low risk	≤ 0
Intermediate risk	1-2
Likely	> 2

Diagnostic strategies for DVT



Annal Int Med 2003

Summary of Pathophysiology

- Deep vein thrombosis (DVT) and pulmonary embolism (PE) are a single clinicopathological entity
  - > venous thromboembolic disease, VTE
- The incidence: **1 (DVT)** and **0.5 (PE)** cases per **1000 population per year** in the **Western world**
- In a hospital setting, 15% of medical and 30-50% of surgical patients develop VTE if no prophylaxis is initiated
- Clinical feature: nonspecific and inaccurate
- Serious complications; ***30-40% mortality*** in **untreated PE**, ***~50% PTS*** **in DVT**
- Clinical risk assessment and plasma D-dimer testing with duplex study and pulmonary CT angiography

Treatment

치료방법

- 약물치료
- 혈관내 시술
- 수술적 방법

Concerns in a patients with DVT

- Pulmonary embolism
- Symptoms
- Extension of thrombosis
- Recurrence
- Post-thrombotic syndrome

=> Aim of DVT treatment

Goals of DVT Therapy

- **Diminish the severity and duration of lower extremity symptoms**
- **Prevent Pulmonary embolism**
- **Minimize the risk of recurrent venous thrombosis**
- **Prevent the postthrombotic syndrome (PTS)**

Overview of Treatment

1. **Systemic Anticoagulation**
2. **Systemic Thrombolysis**
3. Surgical Thrombectomy
4. **IVC filter**
5. **Catheter Directed Thrombolysis (CDT)**
6. **Percuataneous Mechanical Thrombectomy (PMT?)**
7. **PharmacoMechanical Thrombolysis (PMT)**
8. **Adjuvant Venous Angioplasty and Stenting**

DVT: Treatment options

- Anticoagulants
- Thrombolytic therapy

- Pharmacomechanical thrombectomy
- Surgical thrombectomy

- Vena cava filter
- Conservative treatment

Basic

DVT: Treatment options

Goal	Caval filter	Anti-Coagulation	Thrombolytic Therapy	Venous Thrombectomy
reduce PE	+	+	+	+
prevent thrombus extension		+	+	+/-
reduce DVT recurrence		+	+	+/-
restore venous patency			+	+
restore venous valve			+	+
reduce chronic venous insufficiency		+/-	+	+

Treatment

- **Conservative Treatment**

심부정맥 혈전증의 예방


Protect yourself from Deep Vein Thrombosis.
Minimum compression
Medium compression
Maximum compression
Navy
Black
Ecru
Navy
Grey


Percentage of Graduated Compression
50%
70%
100%

심부정맥 혈전증의 예방

Conservative Treatment

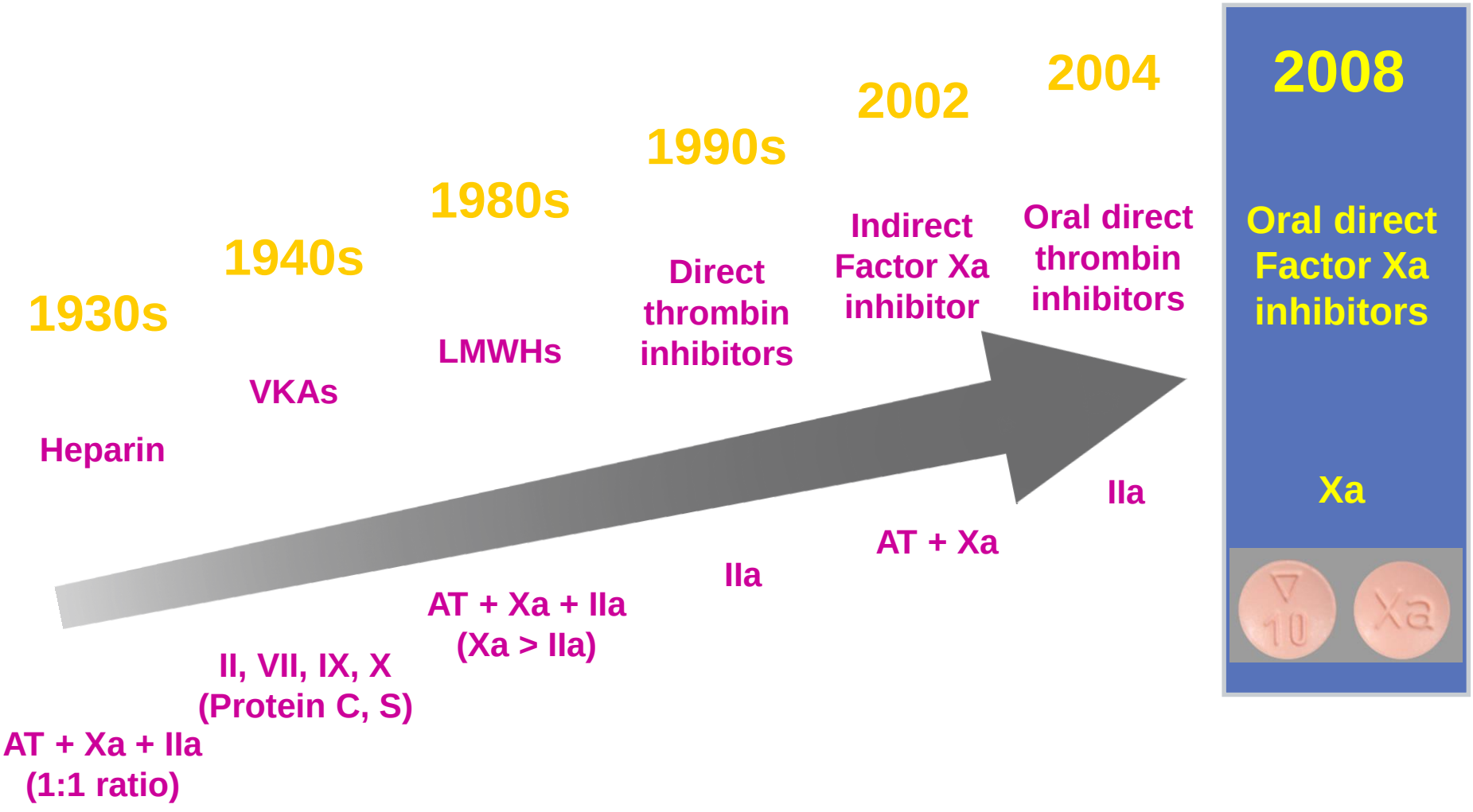
- **Bed rest** and **leg elevation**
  - 1289 prospective cohort study
  - Bed rest does not prevent PE
  - LMWH + early ambulation + compression bandage or ES, faster improvement of pain and swelling w/o increasing risk of PE, decreased PTS
    - Partsch H, JVS 2002
- Graduated **compression stocking**
  - Graduated compression stocking for 24 months post-5 yr cumulative data of incidence of PTS 26% vs. 49%
    - Prandoni P et al, Ann Int Med 2004
- Below-the-knee stocking is equivalent to the thigh one

Treatment

- **Anticoagulation**

Basic

The evolution of anticoagulant drugs



Outpatient Anticoagulation Therapy: Relative CIx

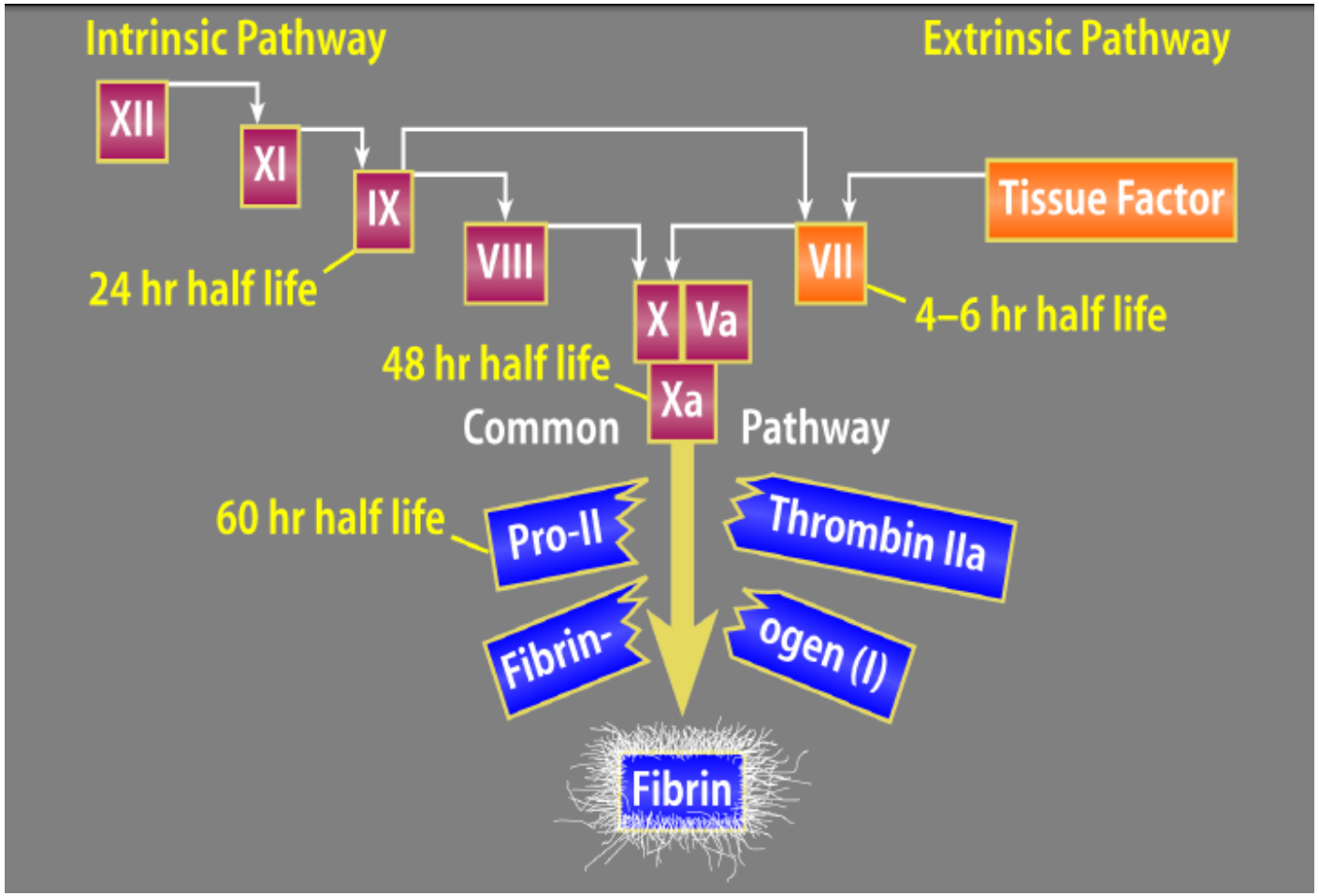
- PE with hemodynamic or respiratory instability
- Extensive iliofemoral thrombus
- Known potential for non-compliance
- Active bleeding
- Severe hypertension (HTN)
- Renal clearance <30 mL/min or SCr >2.5 mg/dL
- Thrombocytopenia <100,000
- History of heparin-induced thrombocytopenia

Michigan Quality Improvement Consortium (MQIC) guidelines 2011

Anticoagulants

- UFH (Unfractionated heparin)
- LMWH (low molecular weight heparin)
- Fondaparinux
- Vitamin K antagonist
- Direct thrombin inhibitor
- Factor Xa inhibitor

Clotting Cascade



Heparin (UFH)

- **Heterogenous mixture** of polysaccharide fragments w/ molecular weight 12,000~15,000

- **Bind to** the **antithrombin**, results **conformational change of AT**, thereby enhance AT's inhibitory effect on thrombin and other coagulation factors esp., Xa

- Drawbacks of unfractionated heparin (UFH)
  - Need to administer heparin by continuous IV infusion
  - Unpredictable activity, requiring laboratory monitoring
  - Heparin induced thrombocytopenia (HIT)

Low Molecular Weight Heparin (LMWH)

- Obtained by various fractionation or depolymerisation of polymeric heparin
- Molecular weight < 8000
- Various activity to the **AT and Xa**
- Constant release → predictable effect, do not need monitoring

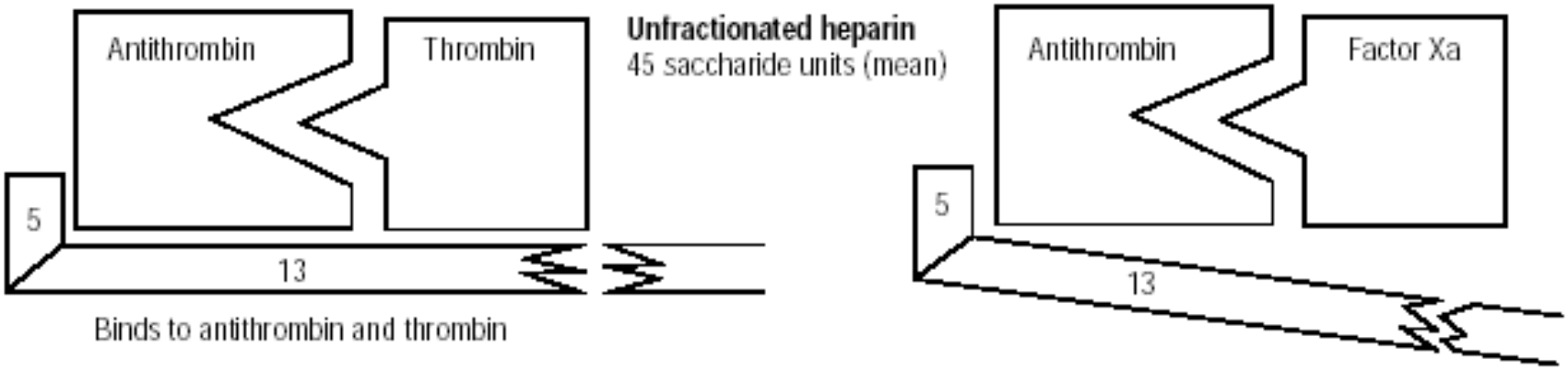
Low Molecular Weight Heparin (LMWH)

Agent	Trade Name	Mean MW	Anti-Xa:Anti-Iia Ratio
UFH	-	12,000~15,000	1
Ardeparin	Normiflo	6,000	1.9
Dalteparin	Fragmin	6,000	2.7
Enoxaparin	Clexane	4,200	3.8
Nadroparin	Fraxiparin	4,500	3.6
Reviparin	Clivarine	4,000	3.5
Tinzaparin	Innohep	4,500	1.9

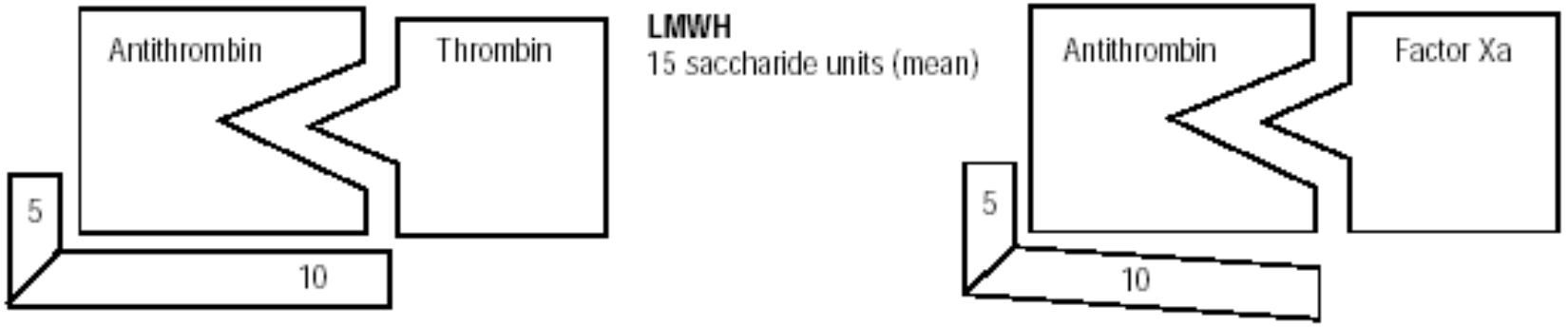
Advantages of LMWH

Pharmacokinetic Characteristic	Clinical advantage
Reduced protein binding	Good bioavailability
	Predictable dose response
	Resistance not encountered
Predictable dose response	Fixed or wt-based dosing possible
	Monitoring not required
Longer plasma half-life	Once- or twice-daily dose possible
Smaller molecule	Improved subcutaneous absorption
Less effect on platelets and endothelium	Reduced incidence of HIT and, possibly, bleeding

Heparin vs. LMWH



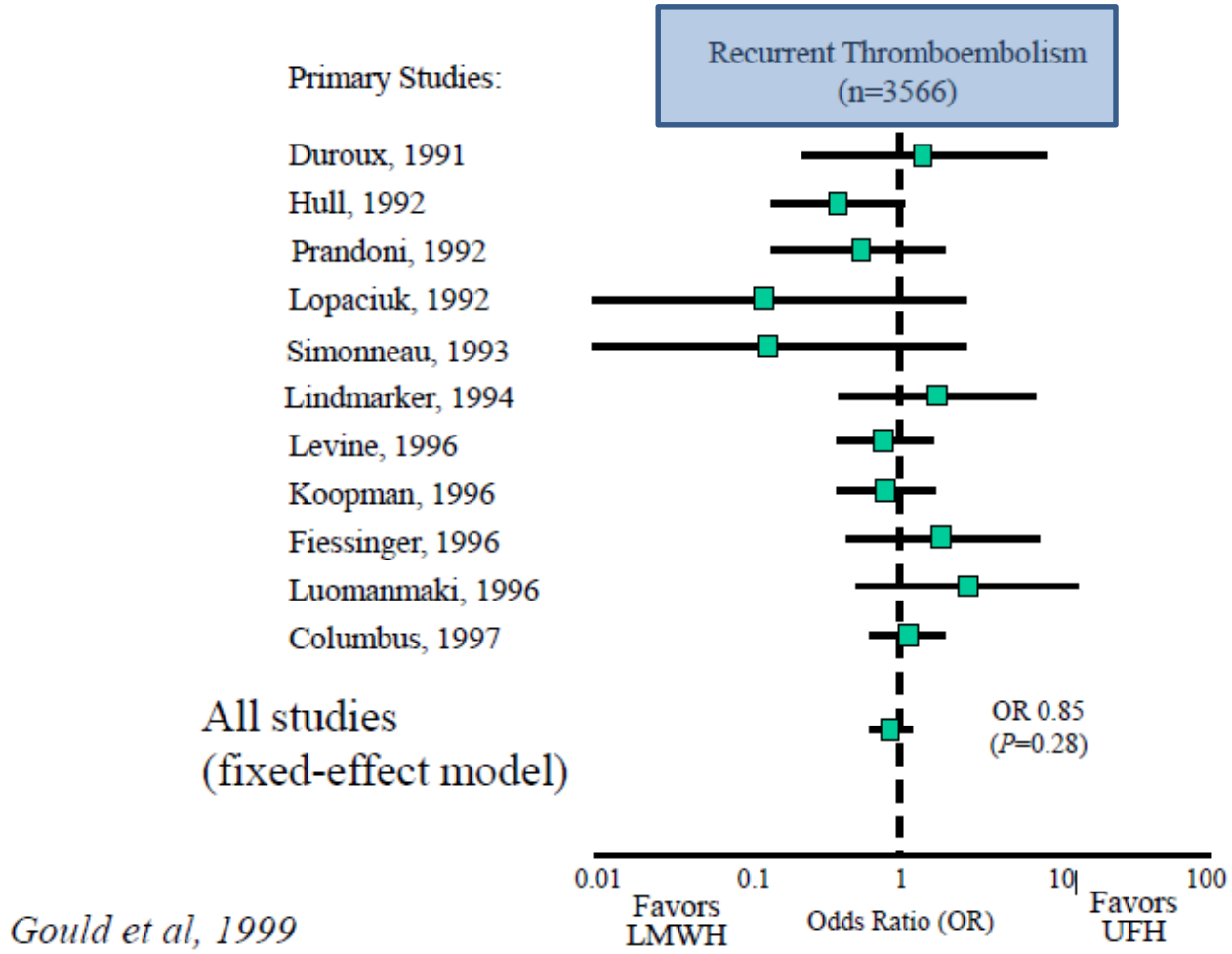
Binds to antithrombin and thrombin



Binds to antithrombin but poorly to thrombin

Binds to antithrombin

Meta-Analysis LMWH vs Heparin for Treatment of DVT



Gould et al, 1999

Fondaparinux

- Synthetic pentasaccharide
- Factor Xa inhibitor
- For injection
- Fondaparinux vs enoxaparin in hip/knee surgery
  - More effective at preventing VTE
  - No difference in major bleeding
- no report of HIT

UFH vs LMWH vs Fondaparinux

	UFH	LMWH	Fondaparinux
Mechanism	Enhances AT effects on Xa & thrombin	Enhances AT effects more selectively on Xa than on thrombin	Enhances anti-Xa activity of AT
Half-life	1-2 hr	4.5-7hr	17-21 hr
Dosing	Continuous drip	BID or once daily	Once daily
Reversal agents	Protamin sulfate 1mg neutralizes 100u of heparin	Protamin sulfate neutralizes 60% of activity	Not reversible by protamin
Monitoring	aPTT, heparin assays	none	none
Clearance	Hepatic & RES, No renal adjustments	Renal Adjust for CrCl<30mL/min	Renal contraindicated in CrCL<30mL/min
Cause HIT	yes	yes	no

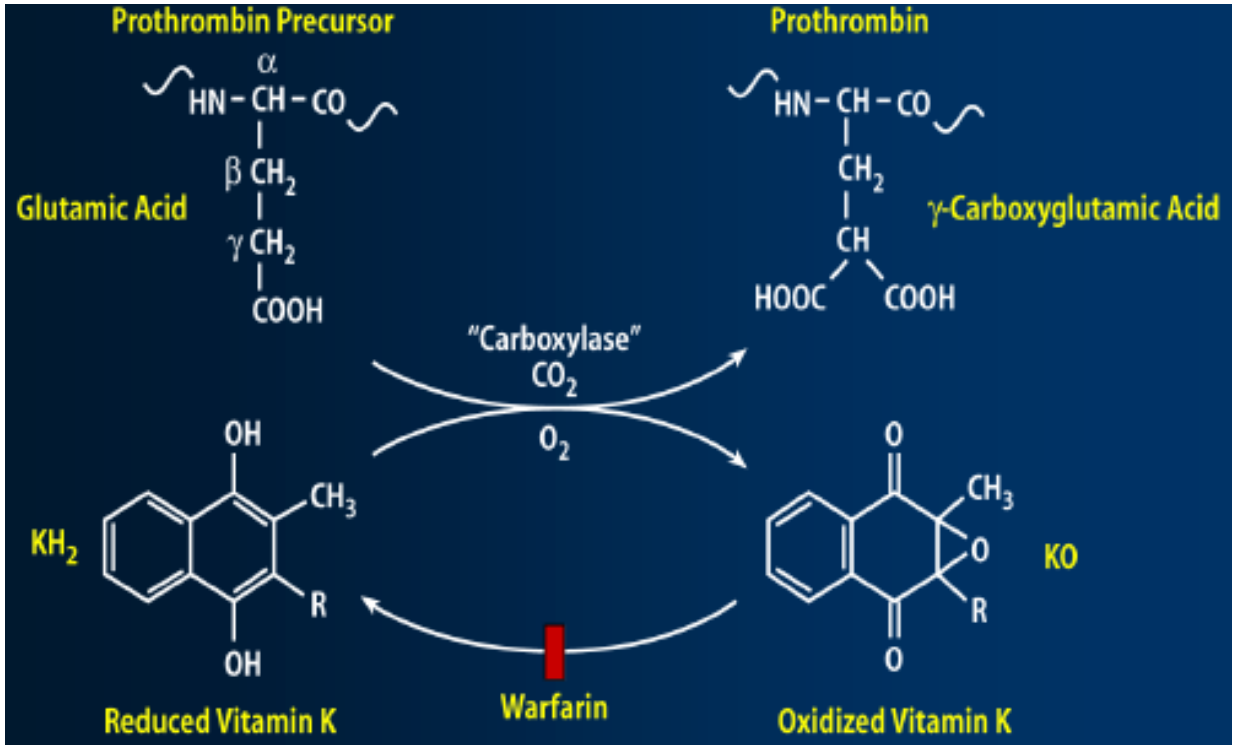
LMWH *vs.* UF Heparin

Recurrences rate	Enoxaparin	UF Heparin	RR (>0.75)
Vein thrombosis event	4.5 %	5.7 %	0.81
DVT	3.1 %	4.4 %	0.79
PE	0.95 %	1.8 %	0.63

LMWH *vs.* UF Heparin

Complication (%)		Enoxaparin	UF Heparin	RR (> 0.75)
Major bleeding	10days	2.2 %	2.0 %	NS
	30days	2.9 %	4.3 %	0.74 (28%)
Death		3.3 %	5.8 %	NS
Mortality				0.69 (31%)

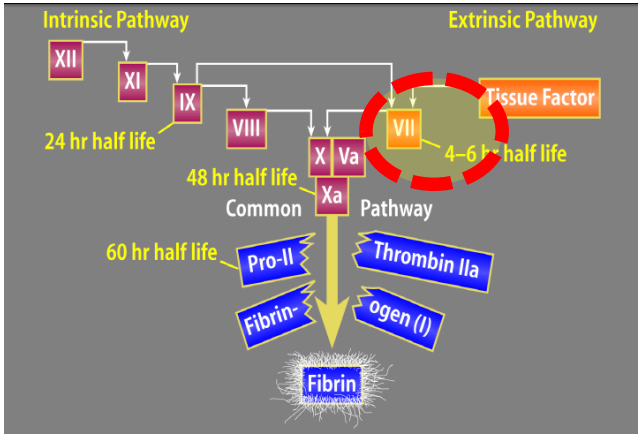
Warfarin : Mechanism of Action



- Inhibit carboxylation of coagulation factor II, VII, IX, X in the liver
- Also inhibits natural anticoagulant protein C/S

VKA should be given with heparin at the begining

- Slow action of VKA
- Relatively hypercoagulable state due to short half life of natural anticoagulants (protein C/S)
- Very short half life of factor VII → initial INR may not reflect effect of VKA



New Oral Anticoagulants (NOACs)

- Factor Xa inhibitors
  - Rivaroxaban
  - Apixaban
  - Edoxaban
- Direct thrombin inhibitors
  - Dabigatran

New ERA of NOAC in VTE treatment

Rivaroxaban (Xarelto®)

EINSTEIN-PE 2012 NEJM
EINSTEIN-DVT 2010 NEJM

Dabigartran (Pradaxa®)

RE-COVER 2009 NEJM
RE-COVER II 2014 Circulation

Apixaban (Eliquis®)

AMPLIFY 2013 NEJM

Edoxaban (Lixiana®)

Hokusai-VTE 2013 NEJM

Pharmacokinetics of NOACs

	Dabigatran	Rivaroxaban	Apixaban
Administration	bid	QD	bid
Bioavailability	6.50%	80%	66%
Tmax	1.25-3 h	2-4 h	1-3 h
Half life	12.14 h	5-13 h	8-15 h
Renal excretion	80%	66%	25%
Plasma protein binding	35%	>90%	87%
Dialysability	Yes	Not expected	Unlikely

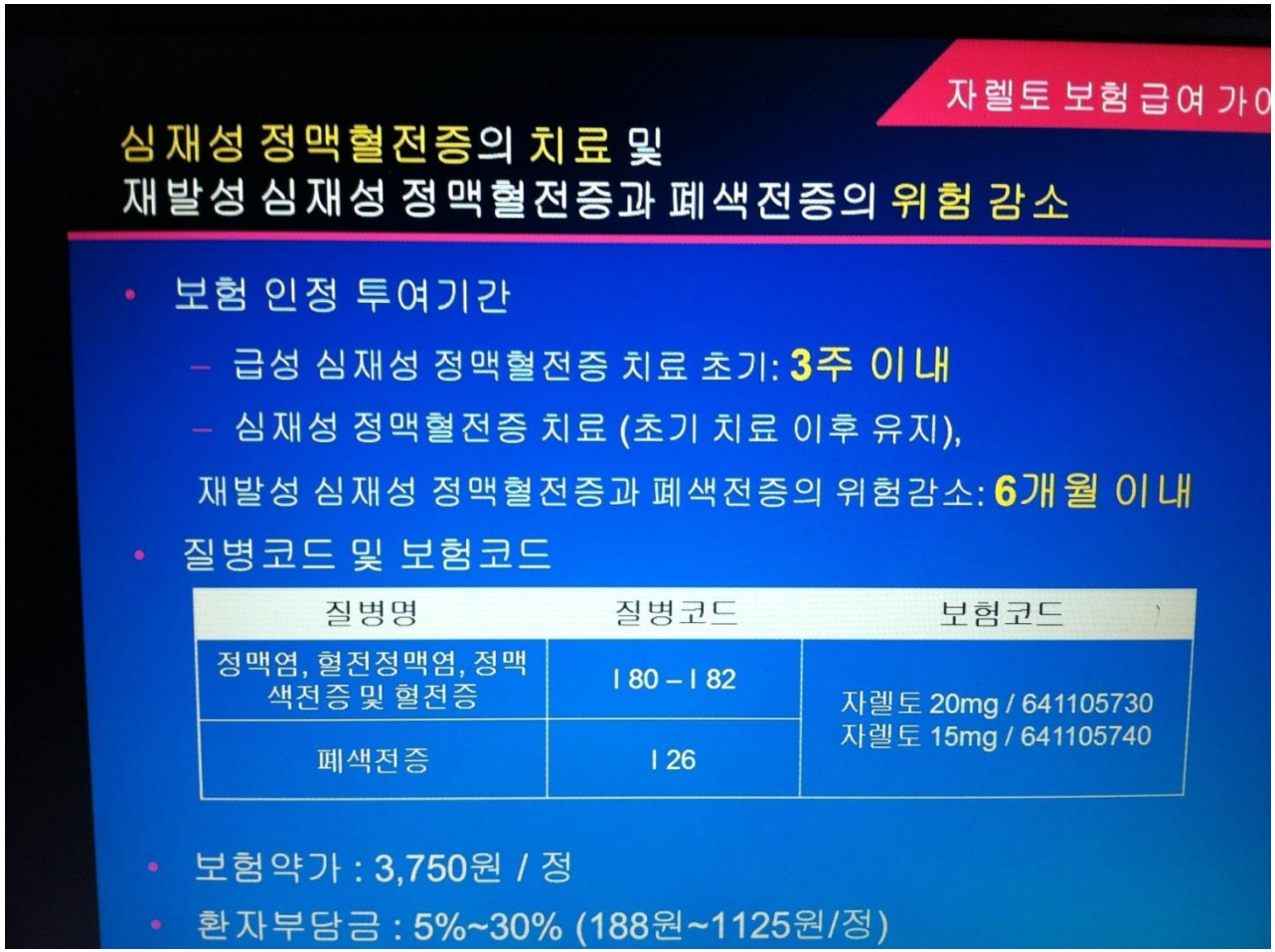
Anticoagulant therapy: Contraindication

- Active bleeding
- Recent CNS surgery : 2 mo
- Recent major surgery : 2 wk
- Recent hemorrhagic stroke 2 mo
- Severe uncontrolled hypertension
- Severe renal and/or hepatic dysfunction

Optimal Duration of Anticoagulant Therapy for Symptomatic Venous Thrombosis

Indication	Duration
DVT with provocative events	3 months
DVT without proviocative cause	6 months to > 1 year
DVT with malignancy	until resolution of malignancy
Hypercoagulable state	life long
Recurrent DVT	life long

보험인증기준


자렐토 보험 급여 가이
심재성 정맥혈전증의 치료 및
재발성 심재성 정맥혈전증과 폐색전증의 위험 감소
• 보험 인정 투여기간
– 급성 심재성 정맥혈전증 치료 초기: 3주 이내
– 심재성 정맥혈전증 치료 (초기 치료 이후 유지),
재발성 심재성 정맥혈전증과 폐색전증의 위험감소: 6개월 이내
• 질병코드 및 보험코드
질병명
질병코드
보험코드
정맥염, 혈전정맥염, 정맥색전증 및 혈전증
I 80 – I 82
폐색전증
I 26
자렐토 20mg / 641105730
자렐토 15mg / 641105740
• 보험약가 : 3,750원 / 정
• 환자부담금 : 5%~30% (188원~1125원/정)

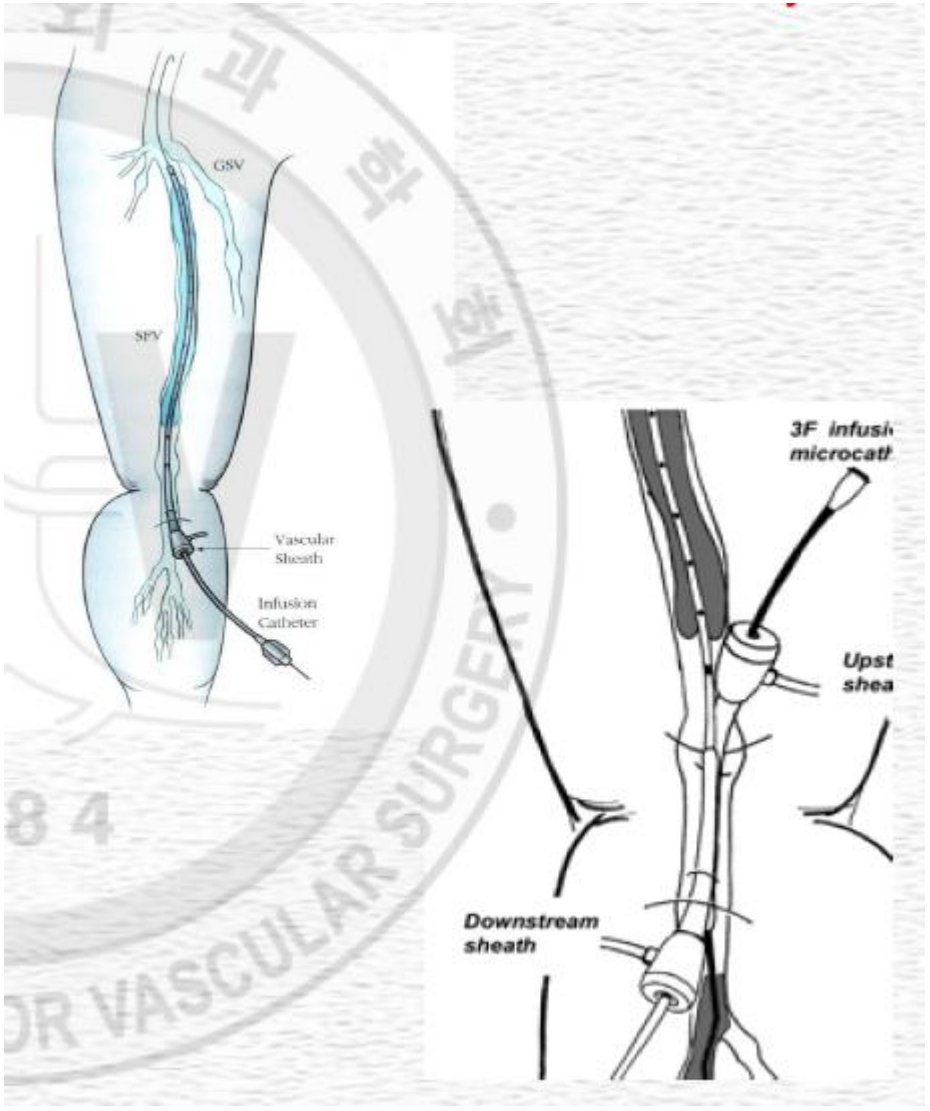
Treatment

- **Catheter Directed Thrombolysis (CDT)**

Catheter directed thrombolytic therapy (CDT)

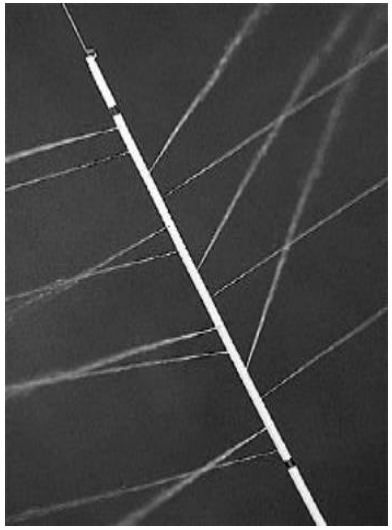
- **Access**
  - Ipsilateral Popliteal vein
  - Contralateral Femoral vein
  - Internal Jugular vein

- **6-F sheath : <u>Heparin</u>**
- **5F multi-sideportcatheter : <u>UK</u>**
  - Heparin 500 unit/hr
  - Urokinase30~100 x 103IU/hr



Catheter directed thrombolytic therapy (CDT)

- Delivery of thrombolytics into the thrombus
- Popliteal approach
- Urokinase>>streptokinase, rtPA – more bleeding
- Pulsed spray catheter



National Multicenter Registry
Radiology 1999

- 287 patients
  - Acute 188, 45 chronic, 54 acute on chronic

- Results
  - Complete lysis 31%, significant(50-99%) 52%, incomplete(<50%) 17%
  - 7.8 million U of UK during 53.4 hrs
  - Higher complete lysis rate in patients with symptoms of less than 10days
  - Major non-fatal bleeding complication 11%
  - Pulmonary embolism in 6 patients, 1 death
  - Overall mortality 0.4%
  - Improved 1 yr patency in treated w/ stent(74%) than w/o stent(53%)

Limitations of CDT

- **Time to lysis**
- Need to hospitalization and intensive monitoring
- **Risk of hemorrhage**
- Cost

Treatment

- **PharmacoMechanical Thrombolysis (PMT)**

Pharmacomechanical thrombectomy(PMT)

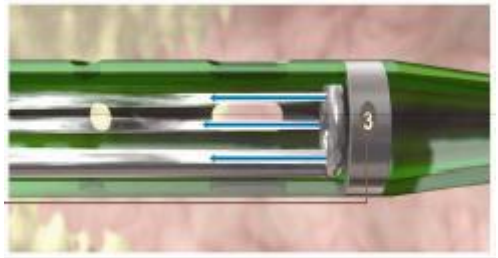
- Reduce dosage of thrombolytic Tx
- Reduce treatment time
- Increase safety
  - narrows contraindications
  - decrease complications
- Reduced cost

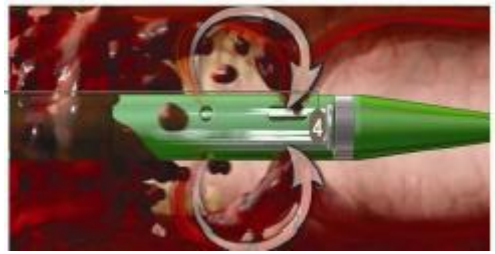
PMT Devices

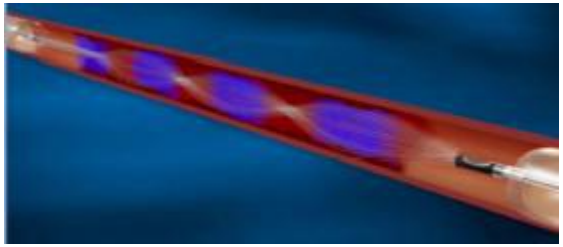
- Aspiration thrombectomy device
- Rotational device
  - Arrow PTD
- Rheolytic thrombectomy
  - **angiojet**, oasis, hydrolyser
- Isolated PMT
  - **trellis**
- Ultrasound accelerated thrombolysis
  - Ekos

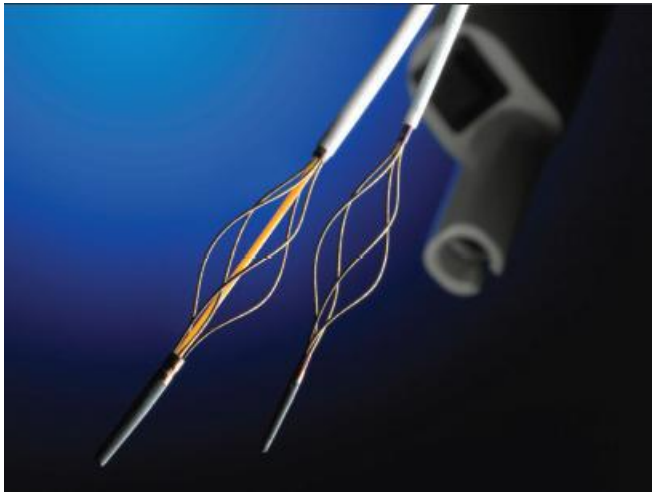
PMT Devices

angioje

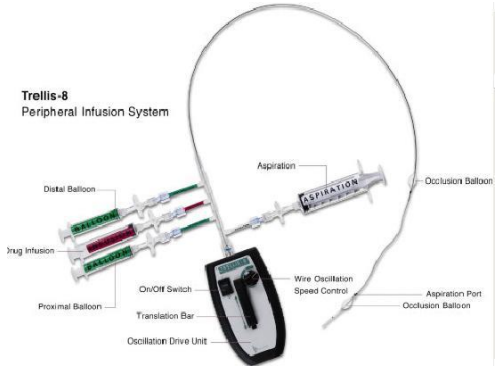








trellis



PMT

Trellis

Angiojet

CDT *vs.* PMT

	complete thrombus remove	partial thrombus remove	angioplasty & stenting
CDT	70 %	30 %	78 %
PMT	75 %	25 %	82 %

Lin PH et al. Am J Surg 2006

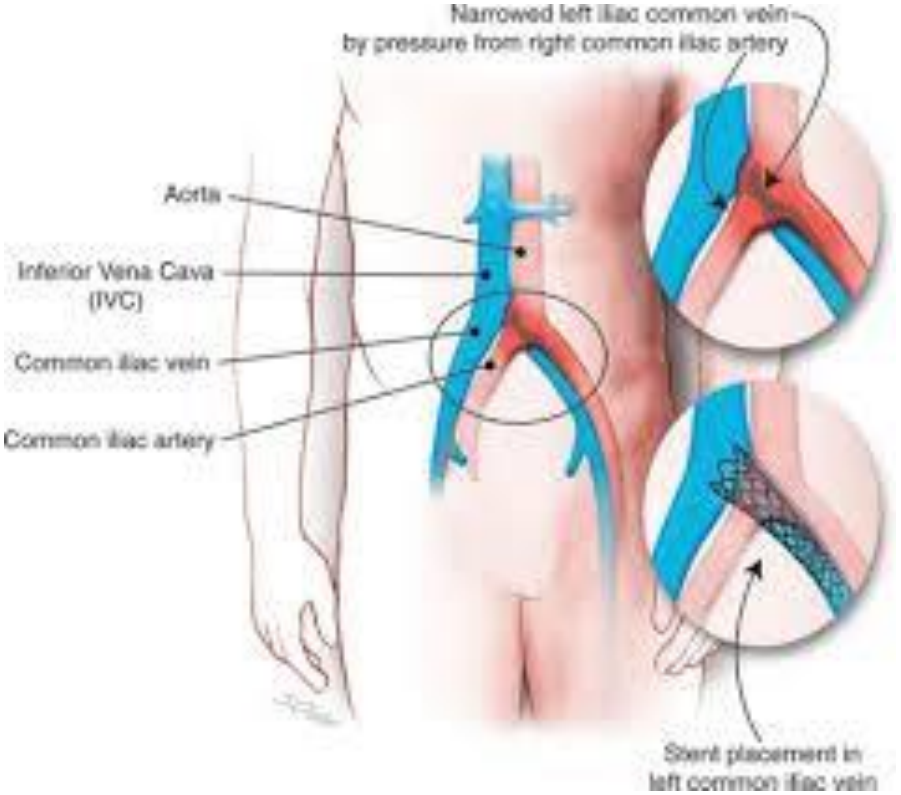
- Compared to CDT, it provided similar treatment success, with reduced ICU, total hospital length of stay, and hospital costs

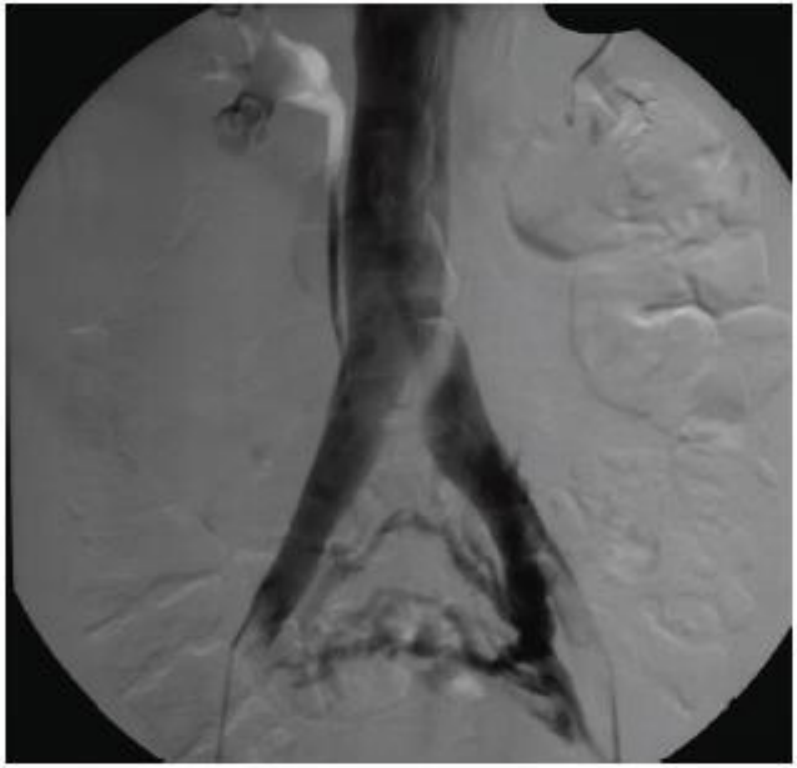
Treatment

- **Adjuvant Venous Angioplasty and Stenting**

May-Thurner Syndrome

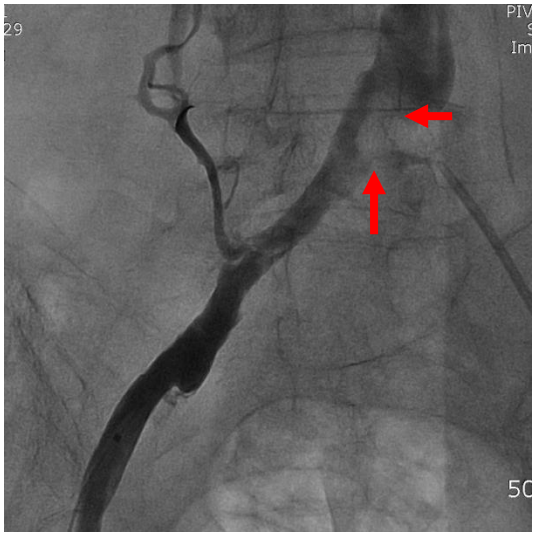
- Iliac vein compression syndrome
  - Compression of the left common iliac vein by the overlying right common iliac artery

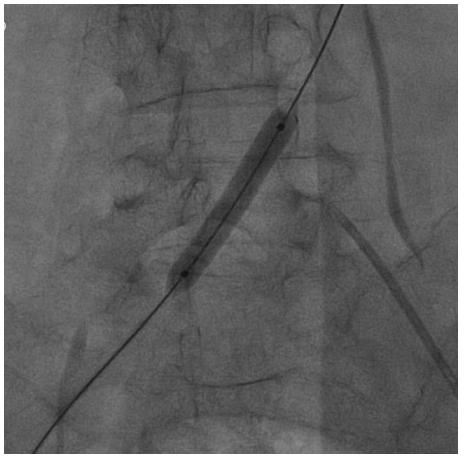


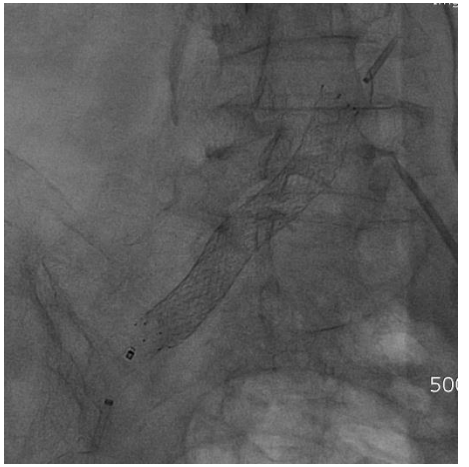


Adjuvant Venoplasty & Stenting

- **Technique**
  - Popliteal vein approach
  - Venoplasty balloon (8~10 mm)
  - Self-expanding stents (10~16 mm)
  - After the procedure, oral warfarin for 6 months

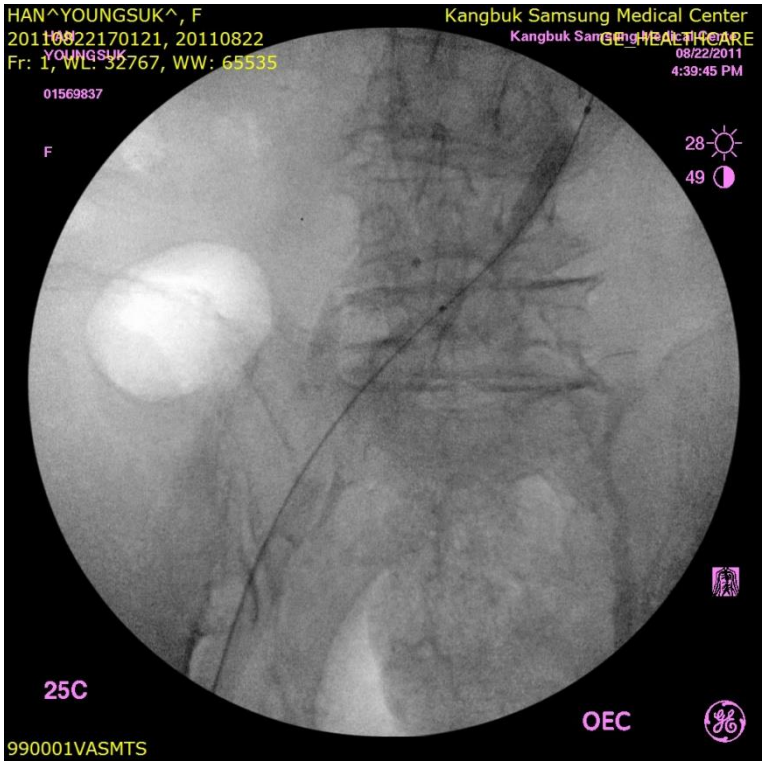


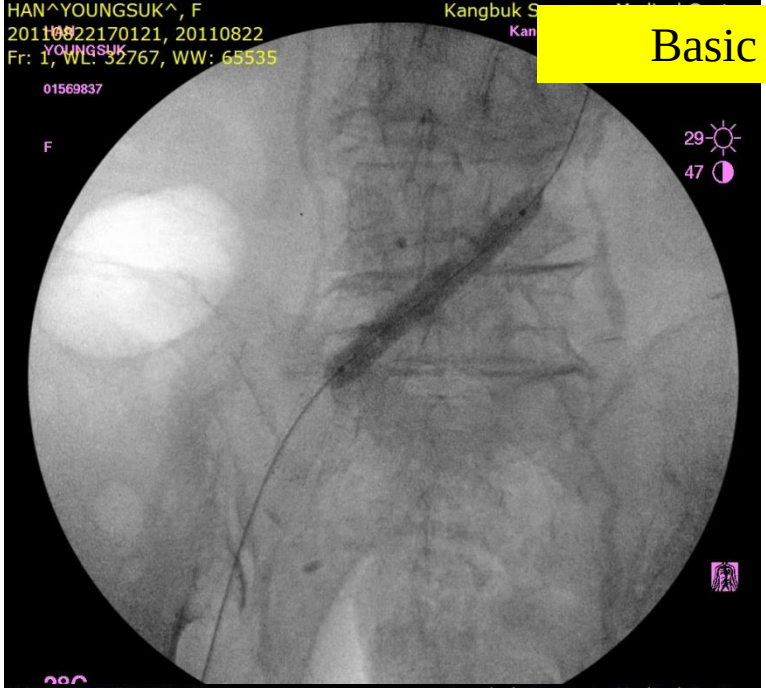


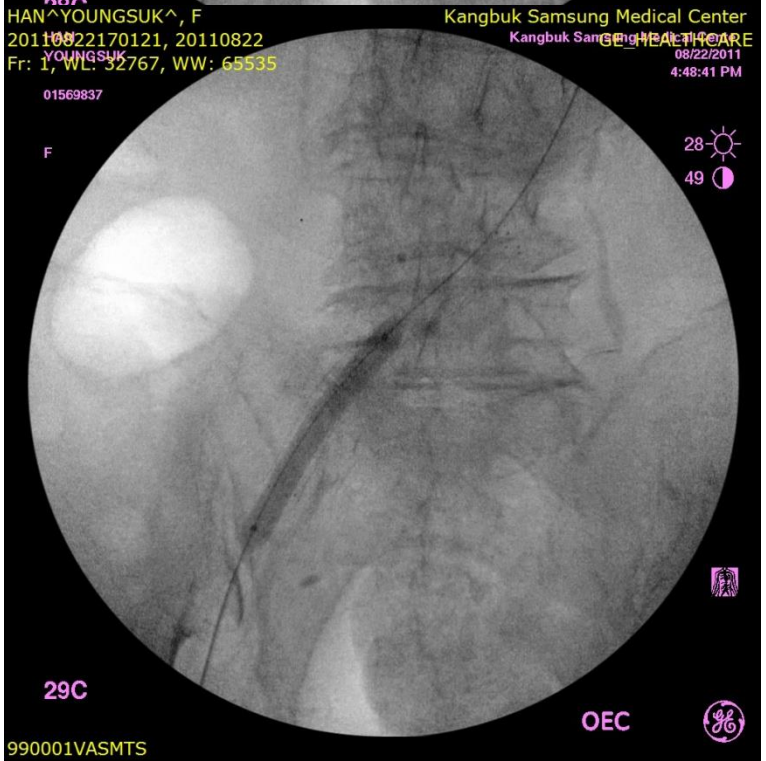


Balloon angioplasty & Stent insertion

Basic







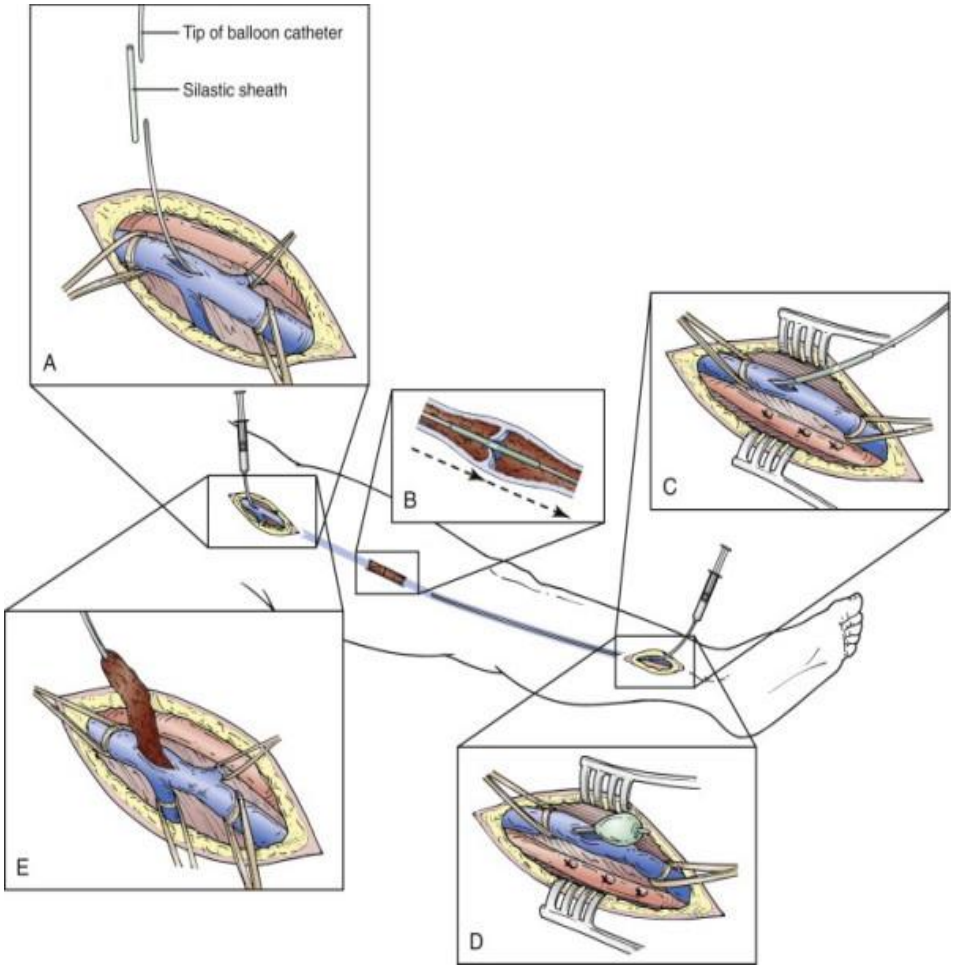
Balloon angioplasty & Stent insertion

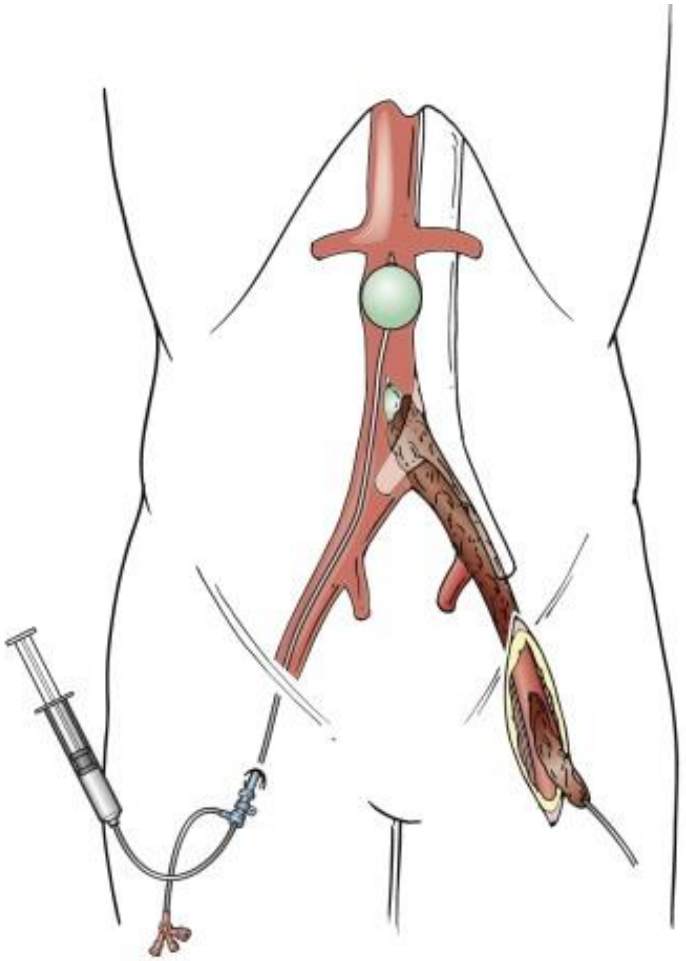
Author (year)	N	Success rate	Primary patency				Sx resolution	Compl ication
			6 mts	1 yr	2 yrs	4 yrs		
O'Sullivan GJ (2000)	39	87%		**92% (A)** **94% (C)**			85%	17%
Hurst DR (2001)	18		89%	**79%**				
Kwak HS (2005)	22	96%		**95%**	95%			9%
Husmann MJ (2007)	11	100%		**90%**	82%		90%	
Oguzkurt L (2008)	36	94%		**85%**		80%	85% (A) 25% (C)	3%

Treatment

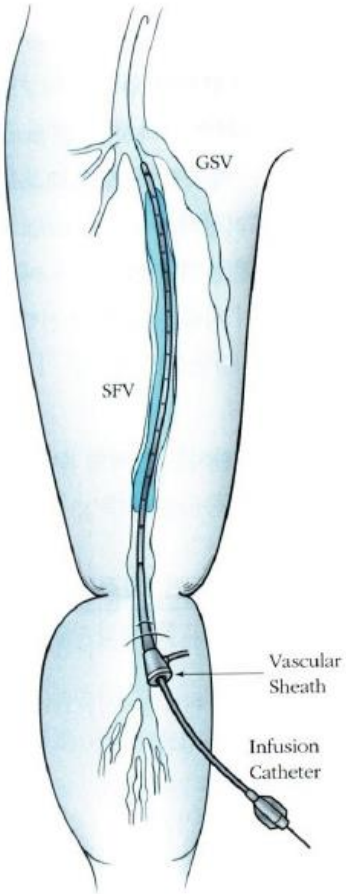
- **Surgical Thrombecotmy**

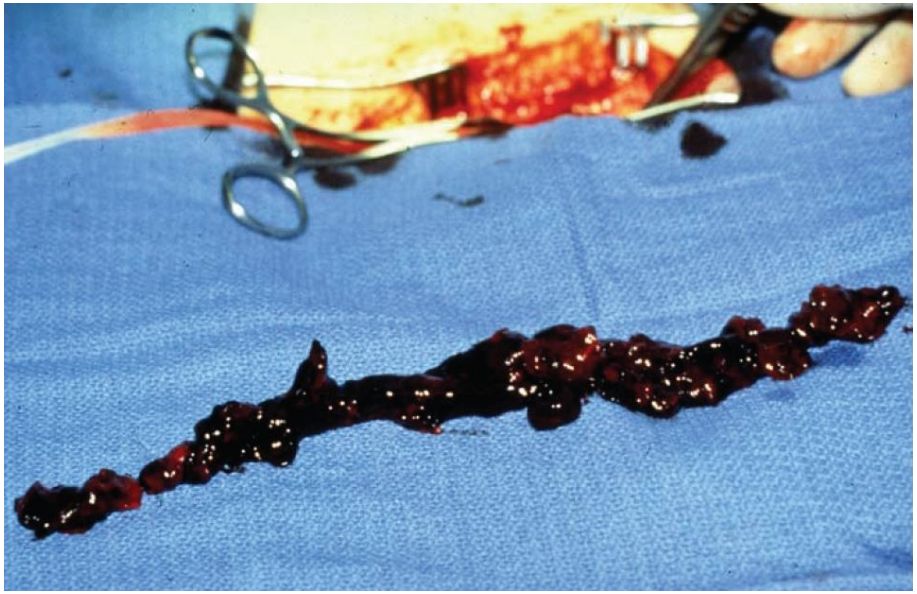
Operative thrombectomy



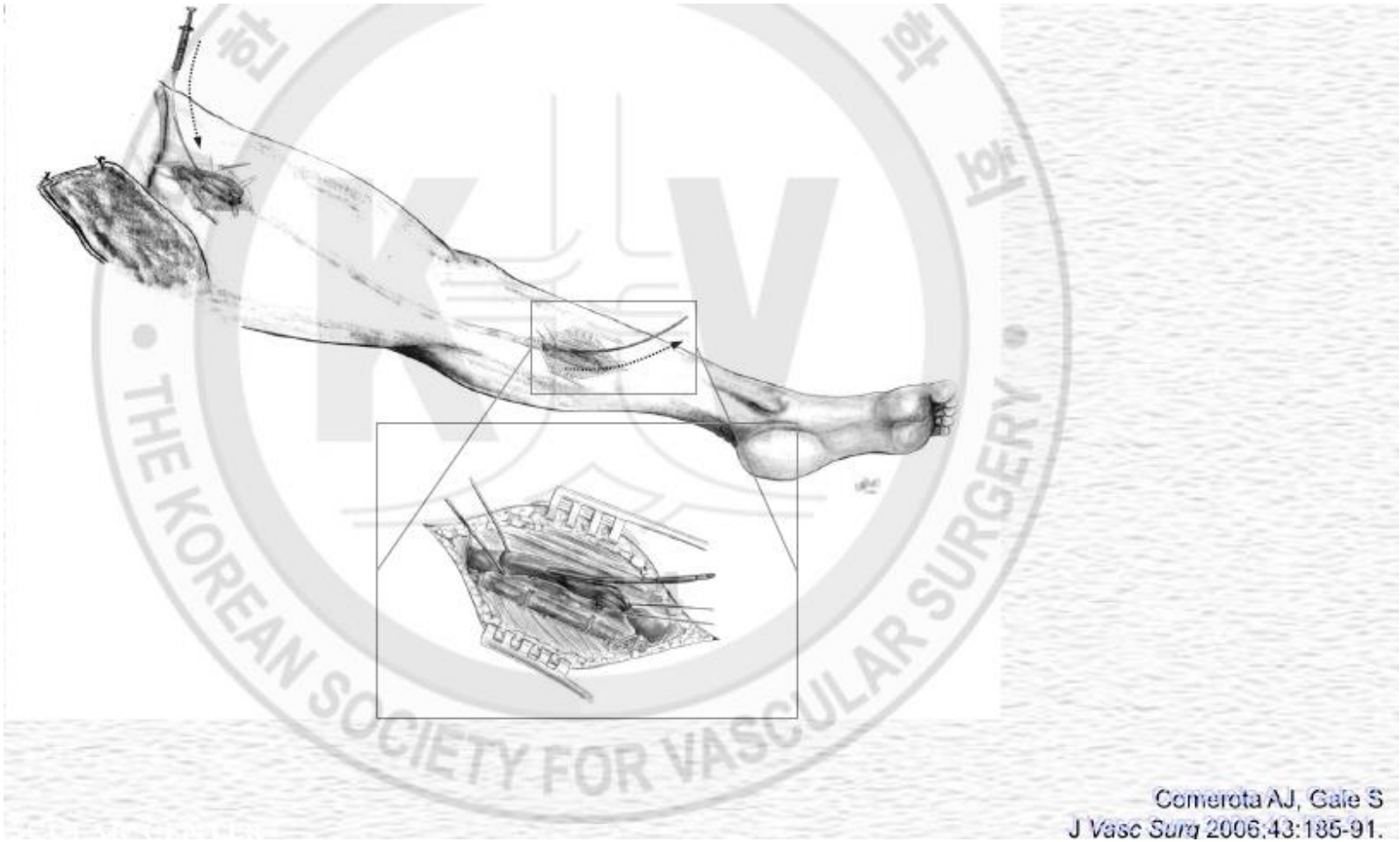


기계적 혈전제거술





Venous Thrombectomy
- infrainguinal Ballon Cathter Passage -

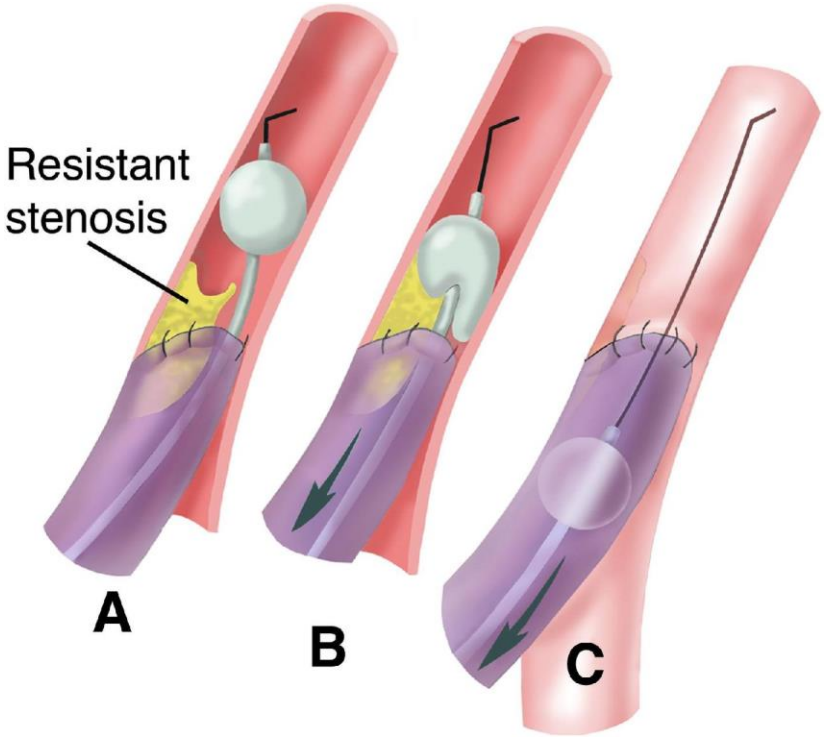


- 소병준, 원광대

Over-wire-Fogarty

Old type

Over-the-wire



Venous Thrombectomy

- Revival of thrombectomy in the management of acute iliofemoral venous thrombosis.
  - 230 thrombectomy
  - No fatal PE
  - 1 operative mortality
  - Early & long-term patency 80% vs 30% of anticoagulated pts
    - Eklof B, Contemp Surg 1992

Venous Thrombectomy

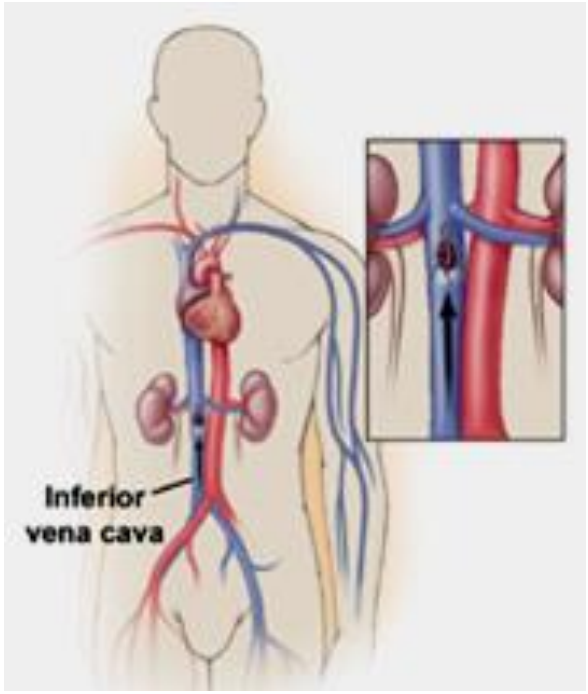
- AVF treatment guidelines for acute DVT
  - Accurate definition preoperatively of the extent of thrombosis, including routine contralateral iliocavography
  - Completion phlebography after thrombectomy to insure the adequacy of thrombectomy & examine residual venous lumen
  - Construction of a small arteriovenous fistula to increase velocity through a thrombogenic iliofemoral venous segment which assists in maintaining patency
  - Immediate & prolonged anticoagulation

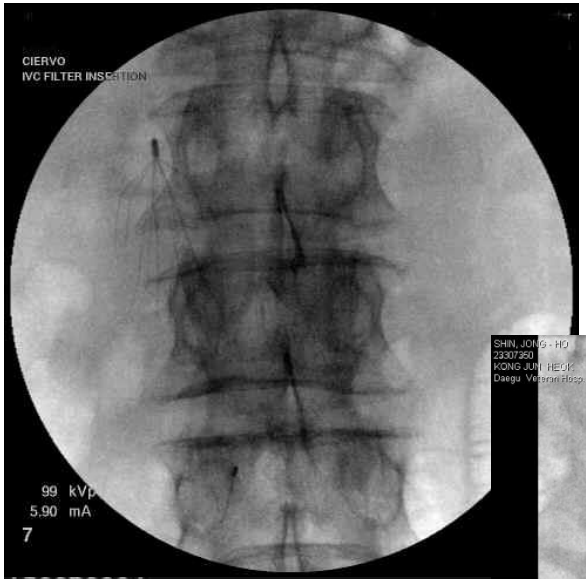
Treatment

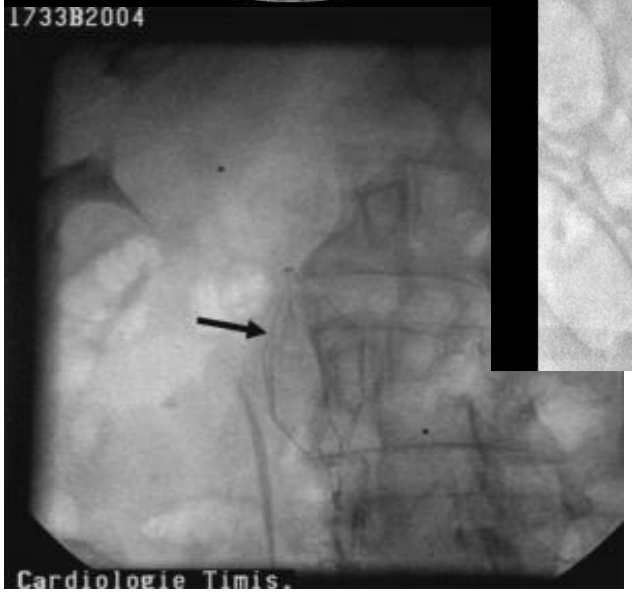
- **IVC filter**

Technique of IVC Filter

- **Approach**
  - Rt or Lt **femoral**,
  - Rt **internal jugular** approach



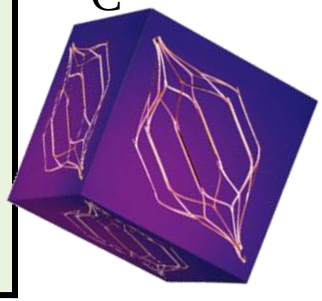


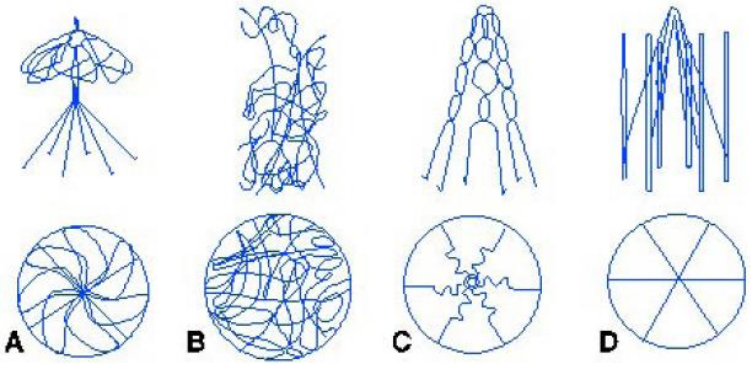


Inferior Vena Cava Filters

Permanent filter	Optional retrievable filter
Simon Nitinol (A) Bird's Nest (B) Greenfield (C) VenaTech (D) TrapEase	Gunther Tulip (A) Cook Celect Filter (B) OptEase (C) Recovery Filter

C

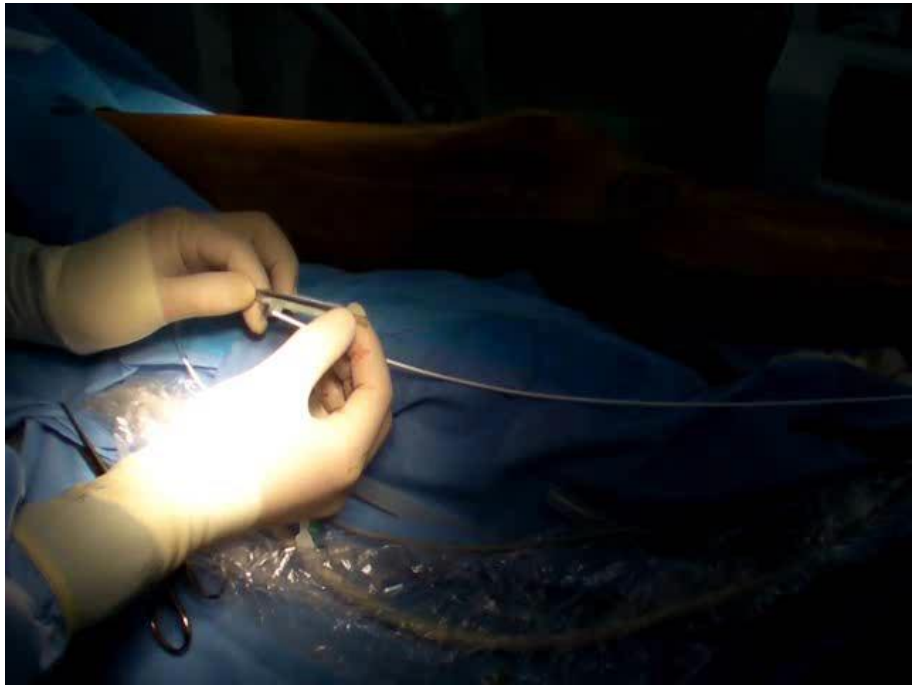




A

B

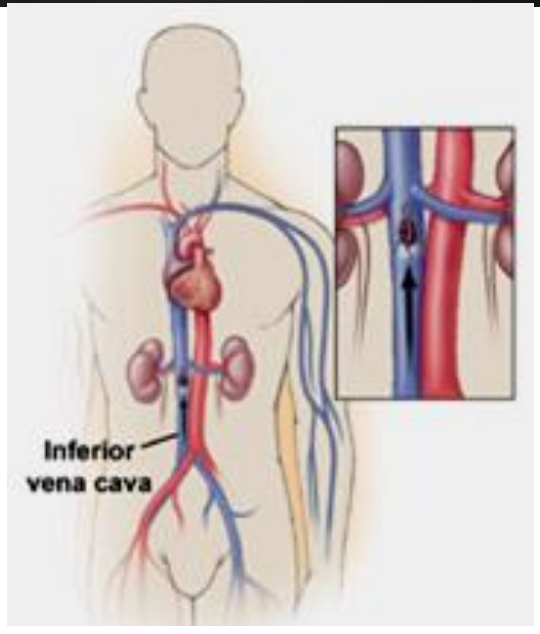
I. IVC filter

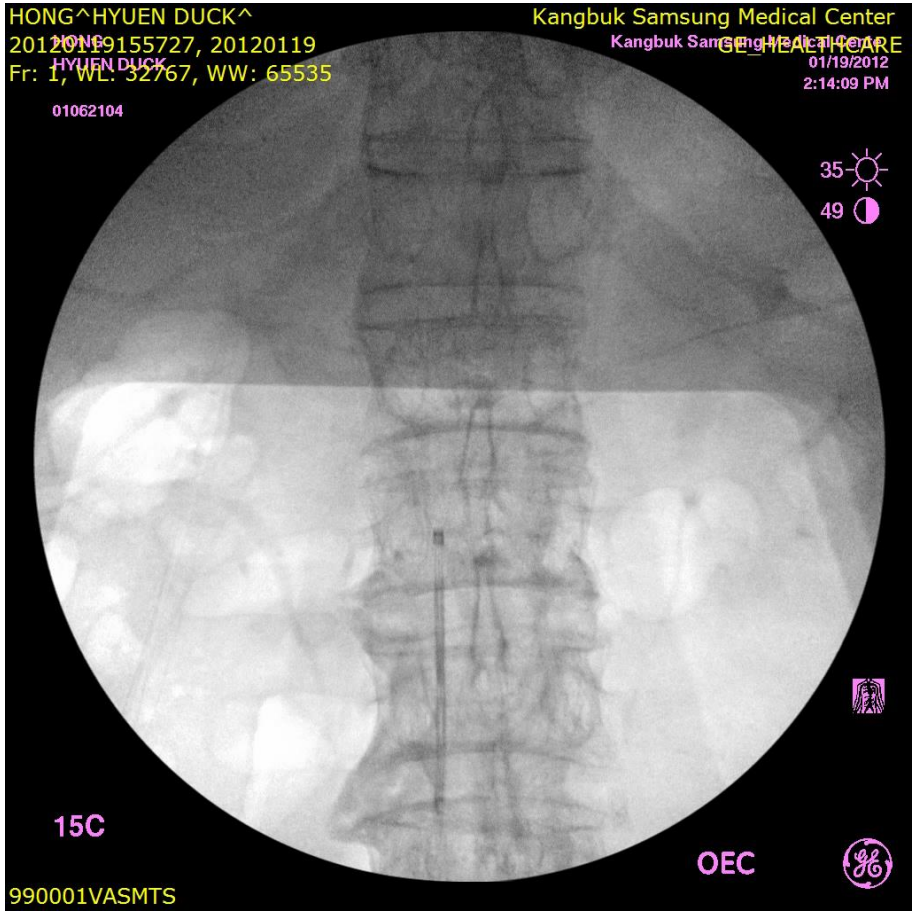


Medial view

I. IVC filter


OptEase filter


Inferior
vena cava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Permanent IVC filter Indication

- Contraindication to anticoagulation
- Patients who experience a complication to anticoagulation treatment
- Recurrent PE
- DVT pts who have cancer, burns
- DVT during Pregnant
- High-risk surgical and trauma patients with a contraindication for anticoagulation

Inferior Vena Cava Filter

- **Absolute** Indication
  - Contraindications to anticoagulation
  - Recurrent thromboembolism despite adequate anticoagulation
  - Complications of anticoagulations that have to be forced the therapy to be discontinued
  - Immediately after pulmonary embolectomy
  - Failure of another form of caval interruption, demonstrated by recurrent thromboembolism

Inferior Vena Cava Filter

- **Relative** indications
  - A large free-floating iliofemoral thrombus demonstrated on venography in a high-risk patient
  - Propagating ilio-femoral thrombus despite adequate anticoagulation
  - Chronic pulmonary embolism in a patient with pulmonary hypertension and cor pulmonale
  - Occlusion of more than 50% of pulmonary bed and would not be tolerate any additional thrombus
  - Recurrent septic embolism

Summary

- **IVC filters**
  - are *not considered* indicated for thrombolysis,
  - **strongly considered**
    - in case of **loose (free-floating) thrombi** or **patients with poor cardiopulmonary reserve**, **filter placement before thrombolysis or mechanical thrombectomy** should be strongly considered.

* Optimal or **retrievable filters** should be considered for this purpose.

Summary (cont'd)

- **CDT** for lower extremity DVT
  - are ***not esblished***,
  - **seriously considered**
    - patients with **iliac and proximal femoral vein thrombosis**, especially who are **younger,**
    - patients with **thrombosis of short duration (less than 10 – 14 days)**

Summary (cont'd)

- **Mechanical thrombectomy**
  - may turn out to **shorten the treatment time**
  - possibly **decrease the risk of complications**, but this remains to be proved
- **Endovascular stents**
  - are used almost **only in the iliac veins**

Highlights in Thrombolytic Management of DVT

- WHAT'S **IN**?
  - **Cather-directed thrombolysis**: **good effect** and **low rate of bleeding** complications

- WHATS'S **OUT**?
  - **Systemic thrombolysis**: because of **a high rate of bleeding complications**

Highlights in Thrombolytic Management of DVT

- WHAT'S **NEW?**
  - **Pharmacomechanical thrombolysis**:
    - is associated with **reduced thrombolysis time**
    - allows **aggressive treatment of underlying pathology**

- WHATS'S **CONTROVERSIAL?**
  - **Aggressive thrombolysis** combined with immediate treatment of **underlying obstructions or other causes**

Basic

Acute DVT

Studies

- Thrombolysis registry 1999
- **Cavent study 2012, 2016**
- PEARL registry 2015
- **Attract study 2013, 2017**
- VIDIO trial 2016

Guidelines

- SIR 2006
- SIR 2009
- SVS 2012
- AHA 2011
- ACCP 2012 9th
- **ACCP 2016 9th update**
- **ESC 2017**

CaVenT trial (2016)

- **Additional CDT resulted in a persistent and increased clinical benefit during follow-up for up to 5 years, supporting the use of additional CDT in patients with extensive proximal DVT**

- **However, allocation to this therapy did not lead to better quality of life**

ATTRACT trial (2017)

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Pharmacomechanical Catheter-Directed Thrombolysis for Deep-Vein Thrombosis

S. Vedantham, S.Z. Goldhaber, J.A. Julian, S.R. Kahn, M.R. Jaff, D.J. Cohen, E. Magnuson, M.K. Razavi, A.J. Comerota, H.L. Gornik, T.P. Murphy, L. Lewis, J.R. Duncan, P. Nieters, M.C. Derfler, M. Filion, C.-S. Gu, S. Kee, J. Schneider, N. Saad, M. Blinder, S. Moll, D. Sacks, J. Lin, J. Rundback, M. Garcia, R. Razdan, E. VanderWoude, V. Marques, and C. Kearon, for the ATTRACT Trial Investigators*

N Engl J Med 2017;377:2240-52.

ATTRACT Trial

- recombinant tissue plasminogen activator (rt-PA) (Activase, Genentech, South San Francisco, CA)
- Good flow to popliteal vein
  - Isolated thrombolysis using Trellis
  - PowerPulse Thrombolysis using the AngioJet
- Pootr inflow to popliteal vein
  - Infusion-First Thrombolysis using a multisidehole catheter
- PTS, defined as a score of ≥5 on the Villalta PTS Scale

Assessment	Baseline	Initial Tx	10 d	30 d	6 m	12 m	18 m	24 m
Leg pain (Likert)	X		X	X				
Leg circumference	X		X	X				
Venous QOL (VEINES)	X			X	X	X	X	X
General QOL (SF-36 version 2)	X			X	X	X	X	X
Duplex ultrasonography	X			X		X*		
Venogram (PCDT arm only)		X†						
Cost diary review			X	X	X	X	X	X
Villalta Scale to assess PTS	X		X	X	X	X	X	X
VCSS					X	X	X	X
CEAP classification					X	X	X	X

Abbreviations: *VEINES*, Venous insufficiency epidemiological and economic study; *SF-36*, short-form 36; *VCSS*, venous clinical severity score; *CEAP*, clinical-etiologic-pathophysiologic-anatomic classification.
* Performed in a subgroup of patients.
† Performed pre- and post-PCDT

ATTRACT trial (2017)

- **Leg pain and swelling** **significantly improved** in PCDT vs no-PCDT out to **30 days** (p=0.019 and p=0.05)

  - In IFDVT mod-severe PTS

    18.4% vs 28.2% in PCDT vs no-PCDT
  - In FPDVT mod-severe PTS

    17.1% vs 18.1% in PCDT vs no-PCDT

ATTRACT trial

- **PTS** : 46.7% for PCDT vs 48.2% for no-PTCD (p=0.56)

- **Recurrent VTE** : 12.5% for PCDT vs 8.5% for no-PCDT (p=0.09)

- **Major** and ***any*** **bleeding** rates statistically higher in PCDT arm (**1.7% vs 0.3%** ; p=0.49 and ***4.5% vs 1.7%***; p=0.034)

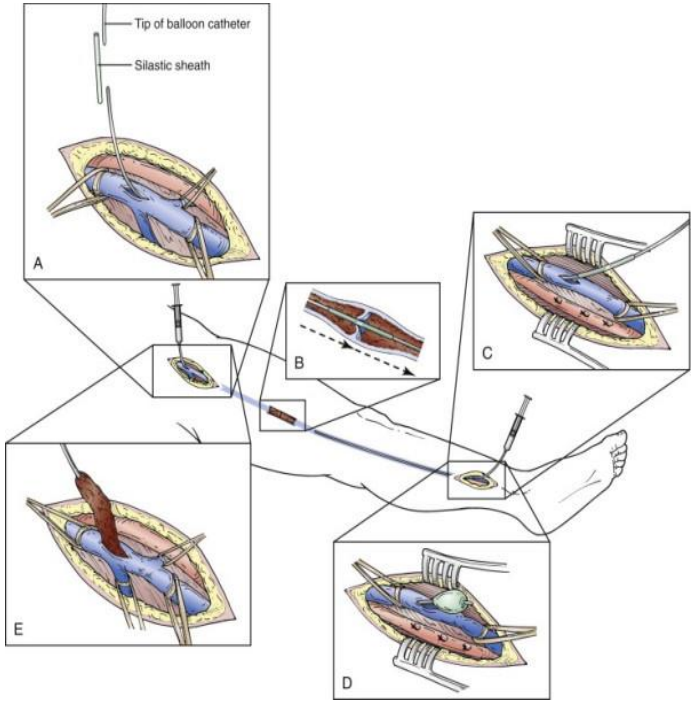
ATTRACT trial

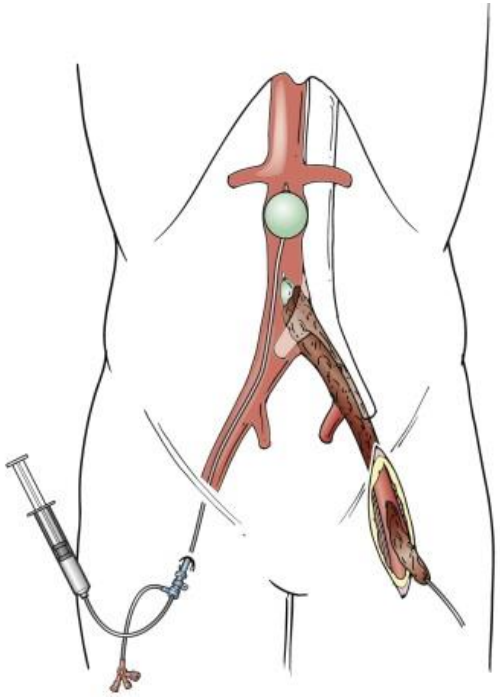
PCDT (pharmacomechanical catheter directed thrombolysis)

- Helpful for **acute symptoms**
- More benefit in **IFDVT**
- **Did not** result in a **lower risk of the PTS**
- Higher risk of **major bleeding**

Hybrid is non-inferior (2016)

- **novel single-incision approach that combines operative and endovascular techniques to maximize thrombus resolution.**





Hybrid is non-inferior (2016)

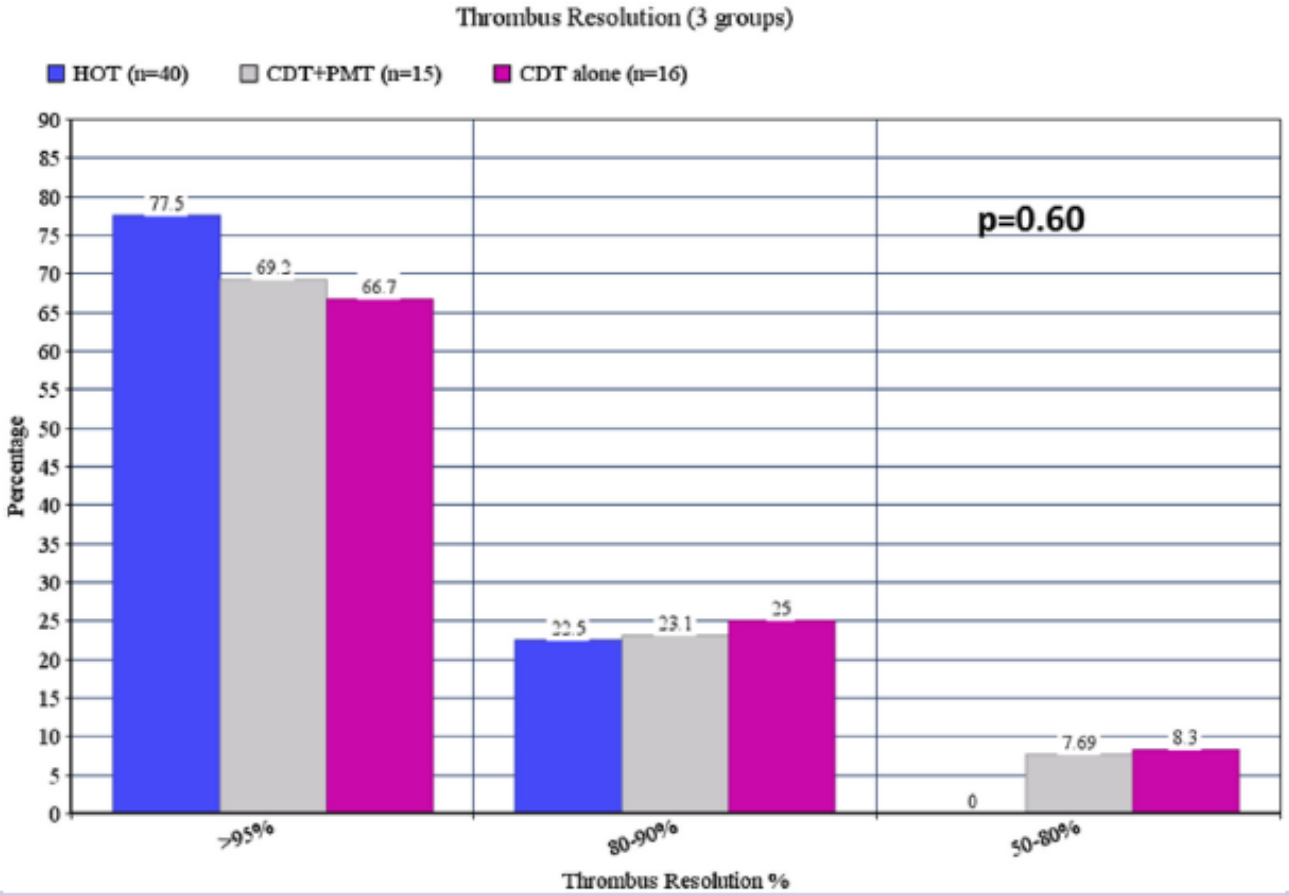
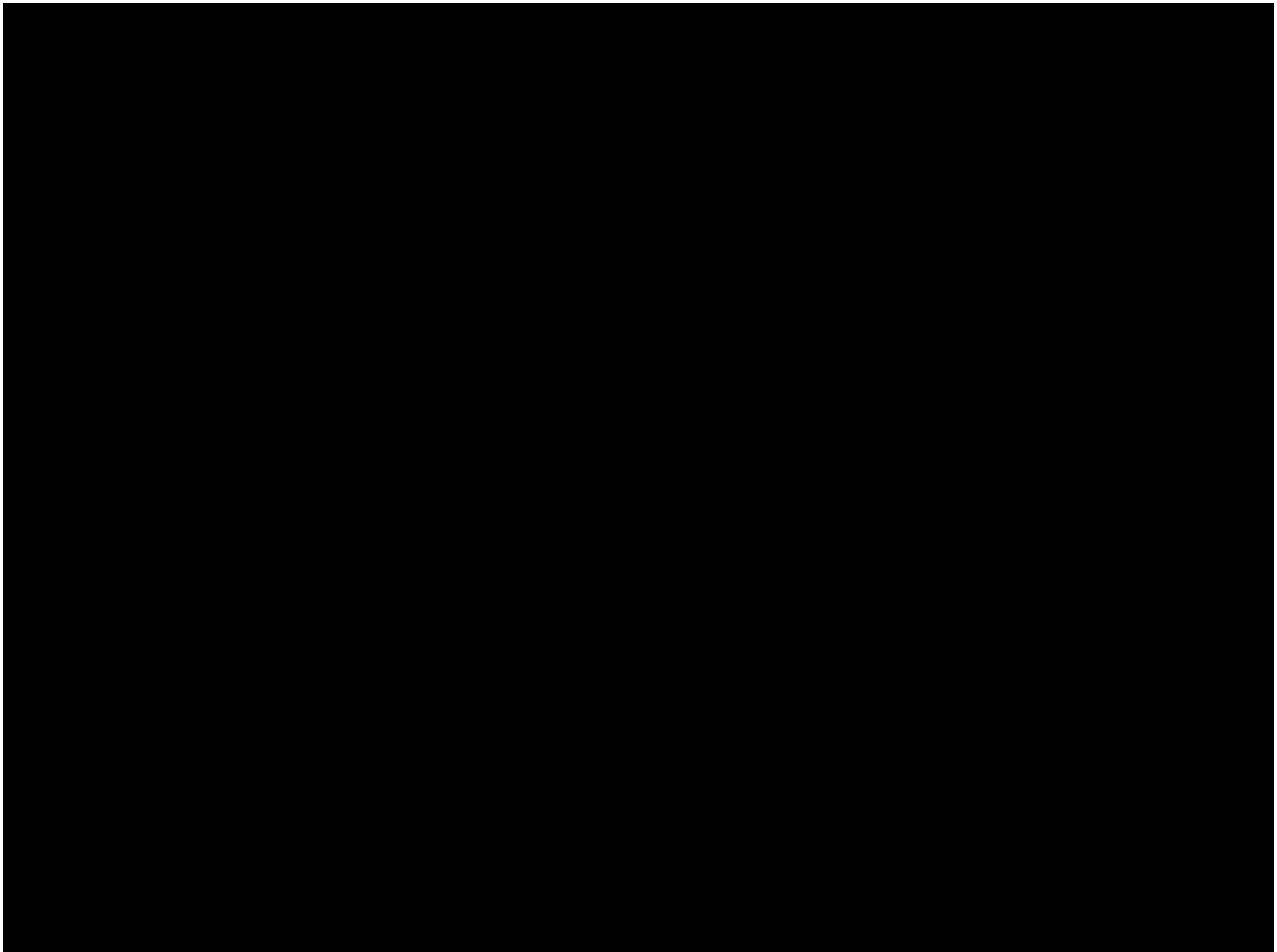


Fig 1. Comparison of degree of thrombus resolution between the groups at completion venography. *CDT,* Catheter-directed thrombolysis; *HOT,* hybrid operative thrombectomy; *PMT,* pharmacomechanical thrombectomy.

HOT thrombectomy established complete (≥ 95%) thrombus resolution more frequently than PT did (78% vs 67%; P = .11

Hybrid Operative Thrombectomy : HOT (youtube: joonhyukkong)



Basic

DVT: Treatment options

Goal	Caval filter	Anti-Coagulation	Thrombolytic Therapy	Venous Thrombectomy
reduce PE	+	+	+	+
prevent thrombus extension		+	+	+/-
reduce DVT recurrence		+	+	+/-
restore venous patency			+	+
restore venous valve			+	+
reduce chronic venous insufficiency		+/-	+	+

Calf Vein Thrombosis (CVT)

Basic

Calf Vein Thrombosis (CVT)

- CVT usually do not cause major sequelae & high risk of PE
- But CVT can embolize, propagation to large veins substantially increases the risk of PE & post-thrombotic syndrome
- Propagation rate : 6-30%
- If not treated, recurrent VTE occurred in 30% of pts.
- 29% recurrent VTE in pts treated w/ 5 days IV heparin vs. no recurrence in pts receiving 3 mo of anticoagulation

Lagerstedt CI, Lancet 1985

Guideline

Basic

Acute DVT

Studies

- Thrombolysis registry 1999
- **Cavent study 2012, 2016**
- PEARL registry 2015
- **Attract study 2013, 2017**
- VIDIO trial 2016

Guidelines

- SIR 2006
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- SVS 2012
- AHA 2011
- ACCP 2012 9th
- **ACCP 2016 9th update**
- **ESC 2017**

ACCP 9th update 2016

Outcomes	No. of Participants (Studies) Follow-up	Quality of the Evidence (GRADE)	Relative Effect (95% CI)	Anticipated Absolute Effects: Risk with Anticoagulation Alone	Anticipated Absolute Effects: Risk Difference with Catheter-Assisted Thrombus Removal (95% CI)
All-cause mortality	209 (1 study) 3 mo	⊕⊕⊖⊖ **Low**[a,b] because of imprecision	RR 0.43 (0.08-2.16)	46 per 1,000[c]	26 fewer per 1,000 (from 43 fewer to 54 more)
Recurrent VTE	189 (1 study) 3 mo	⊕⊕⊖⊖ **Low**[a,b] because of imprecision	RR 0.61 (0.3-1.25)[d]		Moderate-Risk Population[e]
				48 per 1,000	19 fewer per 1,000 (from 34 fewer to 12 more)
Major bleeding	224 (2 studies) 3 mo	⊕⊕⊖⊖ **Low**[a,b] because of imprecision	RR 7.69 (0.4-146.9)[d]		Moderate-Risk Population[e,f]
				29 per 1,000	194 more per 1,000 (from 17 fewer to 1000 more)
PTS	189 (1 study) 2 y	⊕⊕⊕⊖ **Moderate**[a] because of imprecision	RR 0.74 (0.55-1)[g]		Moderate-Risk Population[h]
				588 per 1,000	153 fewer per 1,000 (from 265 fewer to 0 more)[i]
Patency	189 (1 study) 6 mo	⊕⊕⊕⊖ **Moderate**[b] because of imprecision	RR 1.42 (1.09-1.85)	455 per 1,000[j]	191 more per 1,000 (from 41 more to 386 more)
QoL	189 (1 study) 24 mo	⊕⊕⊕⊖ **Moderate**[k] because of risk of bias			The mean quality of life in the intervention groups was 0.2 higher (2.8 lower to 3 higher)[l,m]

The CAVENT Study has reported that CDT reduced PTS, did not alter quality of life, and appears to be cost-effective

A retrospective analysis of CDT (3649 patients) was associated with increase in transfusion(2X), intracranial bleeding (3X), PE(1.5X), and vena caval filter insertion(2X)

This new evidence has not led to a change in our recommendation for the use of CDT in patients with DVT since ACCP 2012

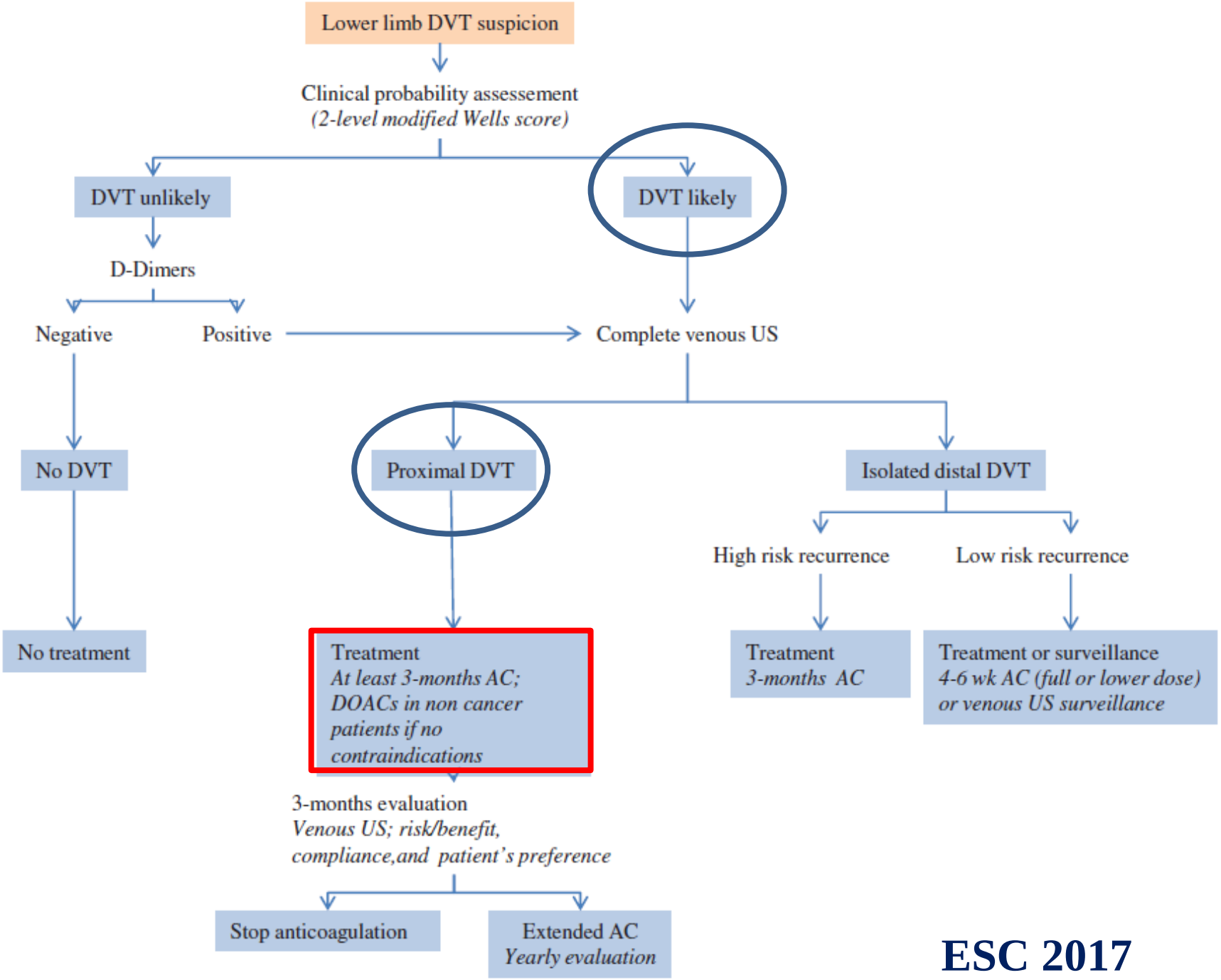
CHEST 2016; 149(2):315-352

Basic

ACCP Guideline 2016

- **Catheter-Directed Thrombolysis** for **Acute DVT** of the Leg
  - In patients with **acute proximal DVT of the leg**, we suggest **anticoagulant therapy alone over CDT (Grade 2C**)
  - We propose that the patients who are most likely to **benefit from CDT** have
    - **Iliofemoral DVT**
    - **Symptoms for <14 days**
    - **Good functional status**
    - **Life expectancy of >1 year**
    - **Low risk of bleeding**

CHEST 2016; 149(2):315-352


Lower limb DVT suspicion
Clinical probability assessement
(2-level modified Wells score)
DVT unlikely
DVT likely
D-Dimers
Negative
Positive
Complete venous US
No DVT
Proximal DVT
Isolated distal DVT
High risk recurrence
Low risk recurrence
No treatment
Treatment
At least 3-months AC;
DOACs in non cancer
patients if no
contraindications
Treatment
3-months AC
Treatment or surveillance
4-6 wk AC (full or lower dose)
or venous US surveillance
3-months evaluation
Venous US; risk/benefit,
compliance,and patient's preference
Stop anticoagulation
Extended AC
Yearly evaluation

ESC 2017

Pregnancy

DVT in pregnancy

- Increased risk of VTE in pregnancy
- Warfarin – teratogenic
- LMWH until delivery

Malignancy

Anticoagulant therapy in pts with malignancy

- Risk of VTE : 11%, 2nd leading cause of death in pt w/ overt malignancy
- Recurrence rate is higher in pts w/ malignancy than without malignancy
- Bleeding complication is higher in pts c malignancy than without malignancy

- Anticoagulant therapy LMWH>VKA
- NOAC – no data availble
- Extended anticoagulation

Anticoagulant therapy in pts with brain tumors

- High risk of VTE : 7.5~25%
  - esp., age≥60 years, glioblastoma, large tumor size, subtotal resection, use of chemotherapy, neurosurgery ≤ 2 mo, leg paresis
- Risk of bleeding: 2~4% in pts w/ glioma,
  - esp., pituitary adenoma, metastatic tumor from melanoma, choriocarcinoma, thyroid ca., renal cell ca.
- Anticoagulant therapy LMWH>VKA

Prophylaxis

Basic

DVT: Prophylaxis

	Calf DVT	Proximal DVT	Fatal PE
High risk	**40-80%**	**10-30%**	**>1%**
• Surgical patients with history of venous thromboembolism			
• Major pelvic or abdominal surgery for malignancy			
• Major trauma			
• Major lower limb orthopedic surgery			
Moderate risk	**10-40%**	**1-10%**	**0.1-1%**
• Geberak surgery in patients >40 years			
• Patients on oral contraception			
• Neurosurgical patients			
Low risk	**<10%**	**<1%**	**<0.1%**
• Uncomplicated surgery in patients <40 years without any other risk factors			
• Minor surgery in patients >40 years without any other risk factors			

DVT: Prophylaxis

- **Pharmacologic**
  - UFH
  - LMWH
  - Fondaparinux
  - Oral direct thrombin inhibitor
  - Factor Xa inhibitor
  - VKA
  - Aspirin

- **Mechanical**
  - Intermittent pneumatic compression

Summary

Therapeutic Goals of DVT Treatment

- **Relieve the patient's symptoms**
- **Prevent further thrombus propagation**
- **Prevent pulmonary embolism & CTEPH**
- **Prevent DVT recurrence**
- **Prevent postthrombotic syndrome**

Acute Pulmonary Embolism

Clinical points

acute, major PE→20% die within 48hrs
→most remaining, resolve over days to weeks

minor: <30% occlusion
PaO2 65~80mmHg
PaCO2 35mmHg

major: 30~50% occlusion
at least 2 lobar pul a obstruction
PaO2 50~60mmHg
PaCO2 <30mmHg

massive: >50% occlusion→50% mortality
PaO2 <50mmHg
PaCO2 <30mmHg
∗ chronic massive embolism→severe PHTN
∗ acute embolism in normal RV function→PA pressure may be normal
↳30~40mmHg=severe PHTN

Supportive & thrombolytic Tx

O2, ventilator support

heparin: IV heparin 70U/kg bolus→18~20U/kg/hr
monitor aPTT 50~70sec every 6~8hr
PLT evey 2~3days for HIT

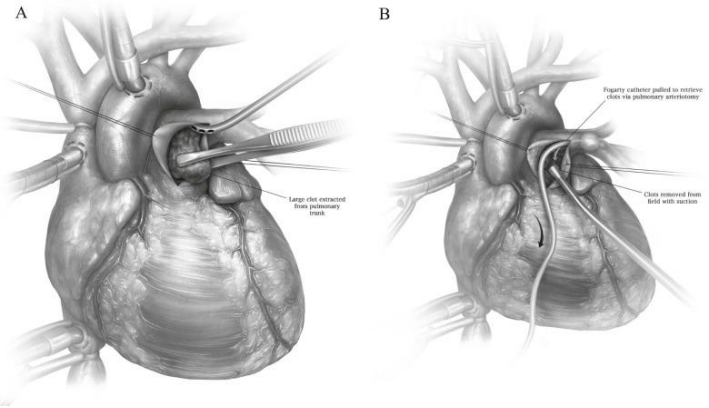
LMWH

Thrombolytics: UK 4400U/kg over 10min→4400U/kg for 12hr
heparin+thrombolytics=more effective & lower mortality rate
contraindication
-fresh surgical wound
-anemia
-recent stroke
-peptic ulcer
-bleeding tendency

Acute PTE Embolectomy

Indication

hemodynamic unstable
major PE c ↓O2 gas exchange
contraindication to thrombolytics or heparin
large trapped clot in RA or RV



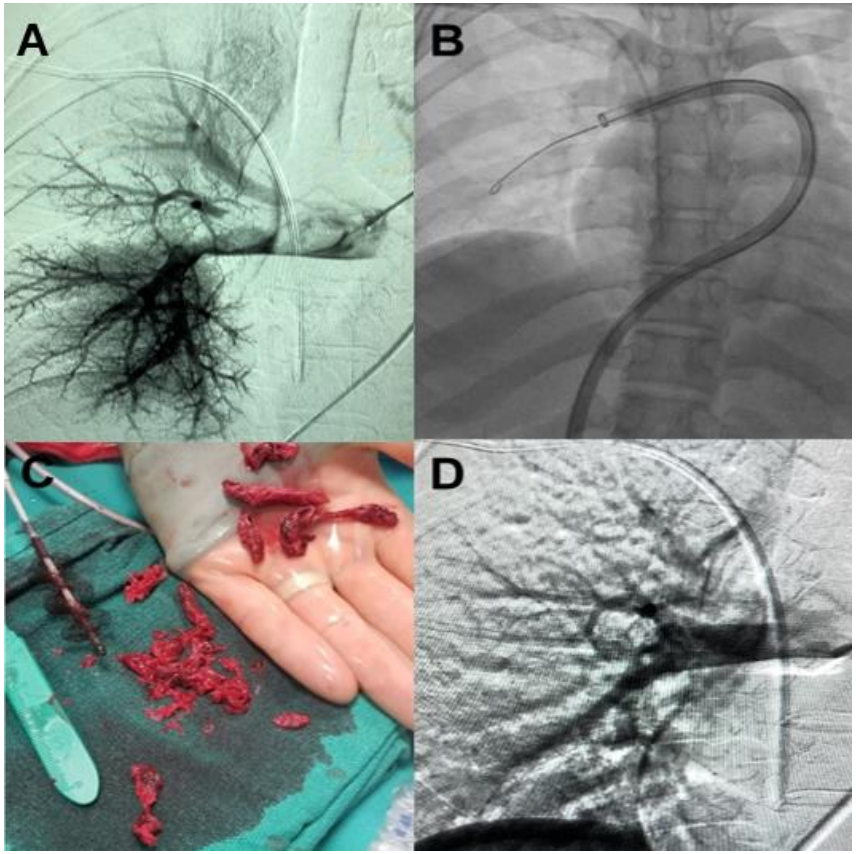
Postop treatment

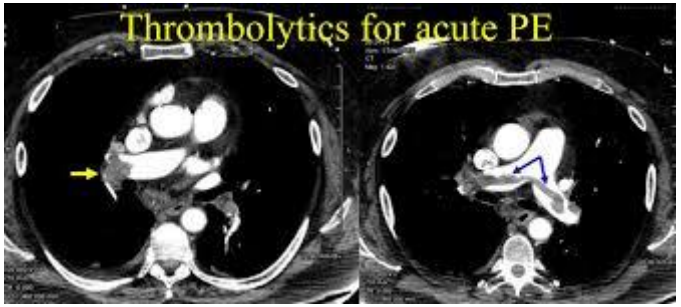
no caval procedures
wafarin for 6mon

IVC filter indication

contraindication to thrombolytics or anticoagulation
to recurrent PE on anticoagulation

Acute PTE





Chronic Pulmonary Embolism

Natural history

acute emboli, not lysed--1~2wk→attach to arterial wall
--with times→converted into connective & elastic tissues
--a few weeks→vessel narrowing, fibrosis

why acute emboli fail to resolve
-unclear
-lupus anticoagulant
-deficiency of protein C, S, AT-III

PHTN >40mmHg→30% will survive at 5 years
>50mmHg→10% will survive at 5 years

chronic process involve proximal PA from pul. trunk to sublobar PA

infarction is infrequently

Surgical indication

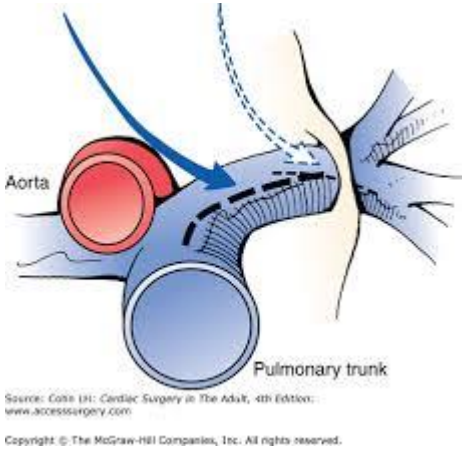
Purpose

• hemodynamic goal: ameliorate RV compromise d/t PHTN

• respiratory goal: improve lung function by removal of non-functioning space

• prophylactic goal: prevent progress RV dysfunction, retrograde extension of clot

prevent secondary vasculopaty



Indication

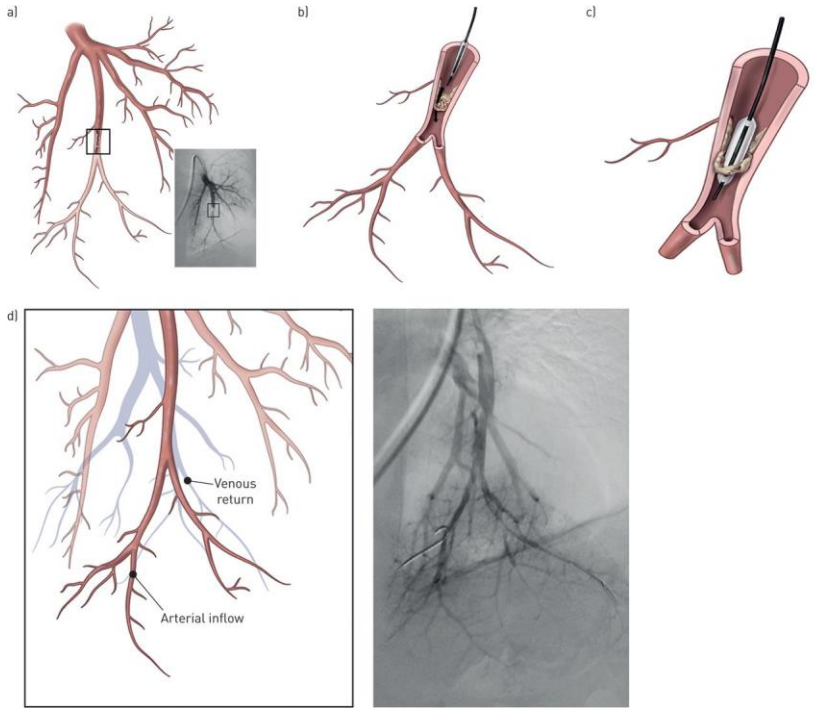
• symptomatic & hemodynamic or ventilatory impairment

• increased PVR

• lobar, segmental, PA occlusion

Basic

Chronic PTE Endo



Vascular Surgeon with Balance