Vascular Problems in the Critical Care

Arterial Embolism: Update

Prof. Dr. Şeref Alp Küçüker

Cardiovascular Surgery Clinic,
Atatürk Education and Research Hospital,
Ankara

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Acute Arterial Occlusion

"The operation was a success but the patient died"

- High Morbidity and Mortality

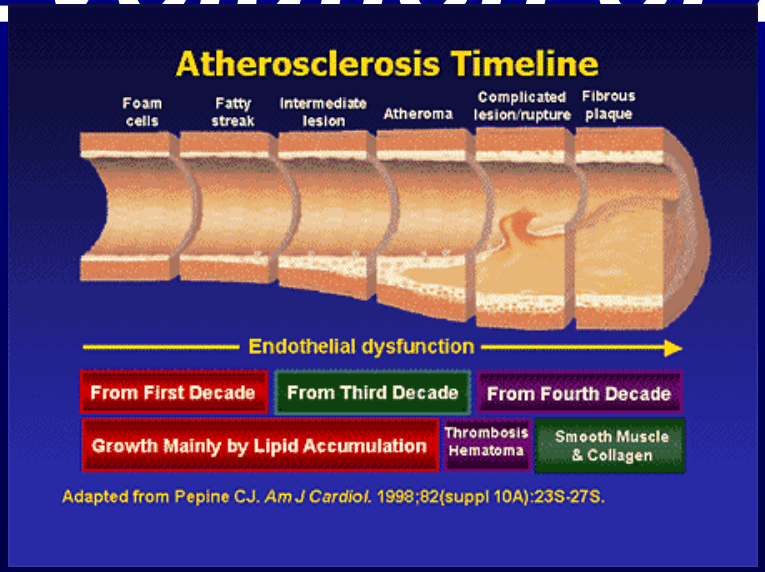
–Emergent operations in high risk patients
–20% mortality reported (Dale, JVS 1984)
–Endovascular approaches may lower peri-procedural mortality while preserving outcomes

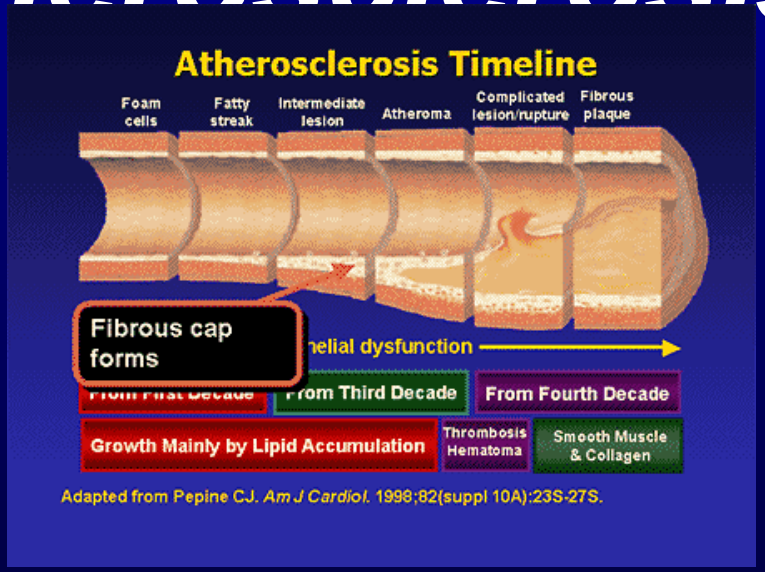
Etiology of Arterial Occlusion

Overview

- Atherosclerosis
- Thrombotic occlusion
- Embolic occlusion
- Treatment Options

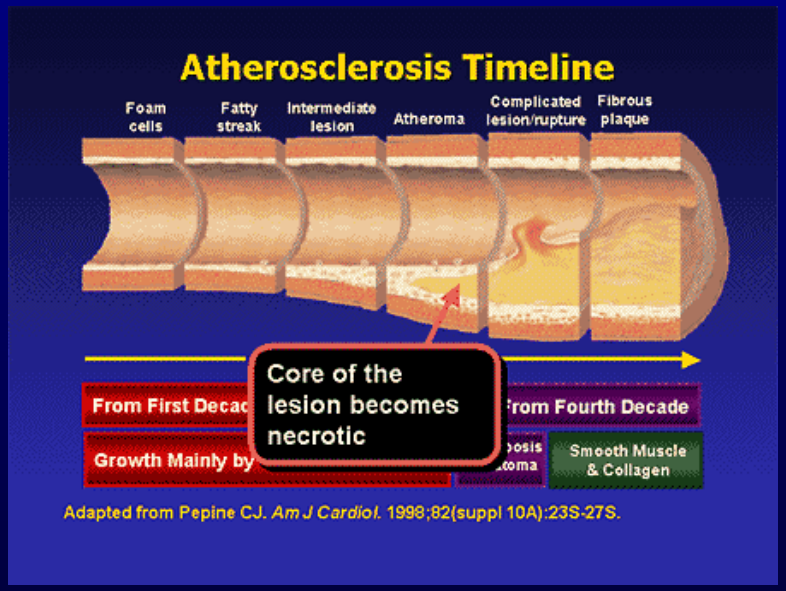
Evolution of Atherosclerosis

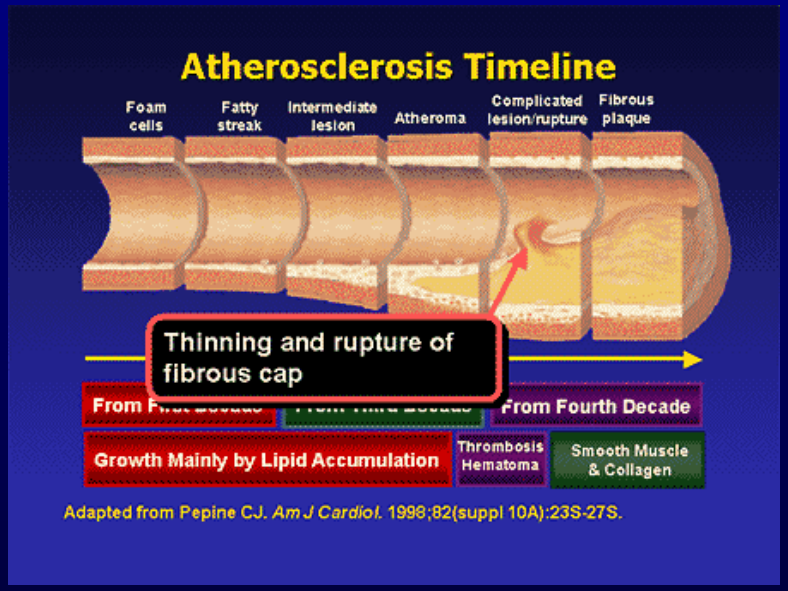




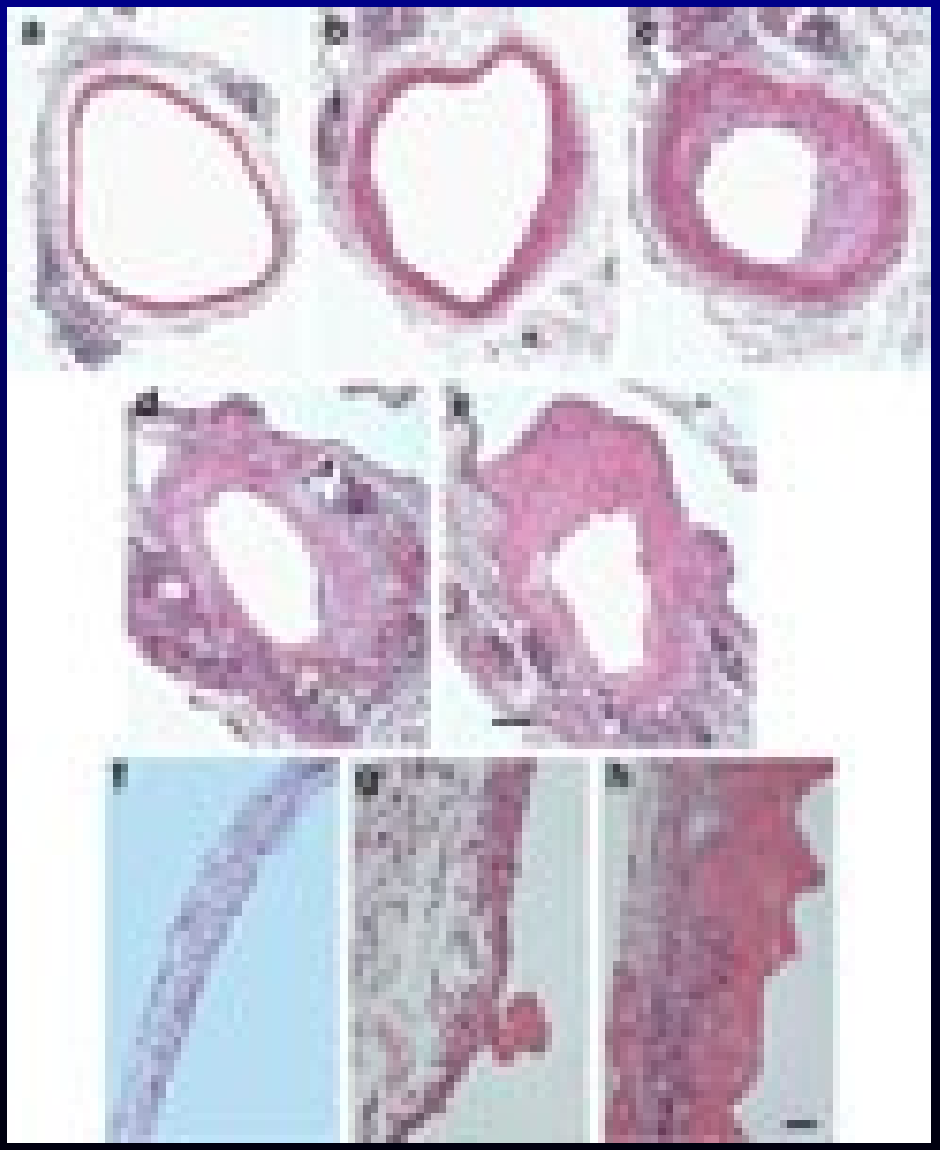
- Areas of low wall shear stress
- Increased endothelial permeability
- Sub-endothelial lipid and macrophage accumulation
- Foam cells
- Formation of Fatty Streak
- Fibrin deposition and stabilizing fibrous cap

Evolution of Atherosclerosis





- Necrosis
- Inflammatory environment
- Destabilization of fibrious cap



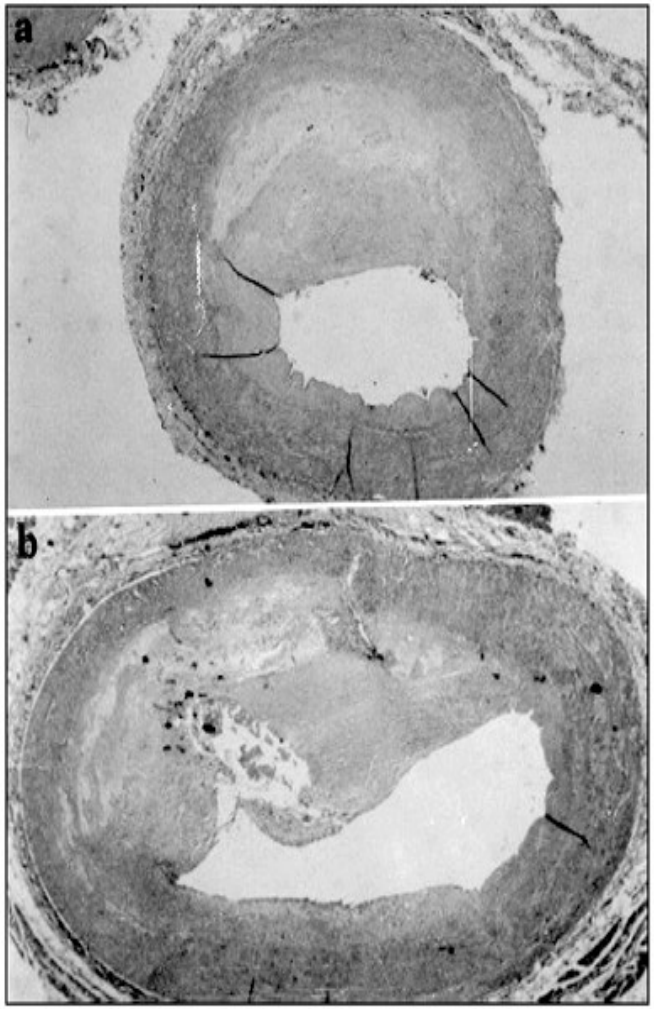
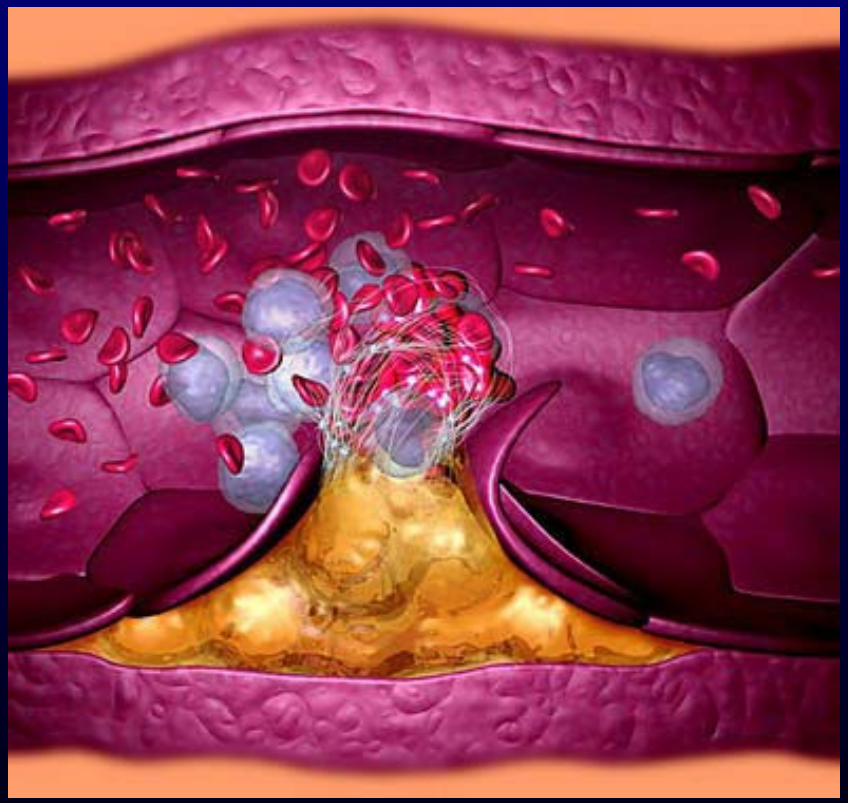


Figure 1 – Representative sections of stable (A) and unstable (B) plaque. A) See the significant thickness of the fibrous cap. B) See the site of plaque rupture. (Material from the Pathology Laboratory of Incor).

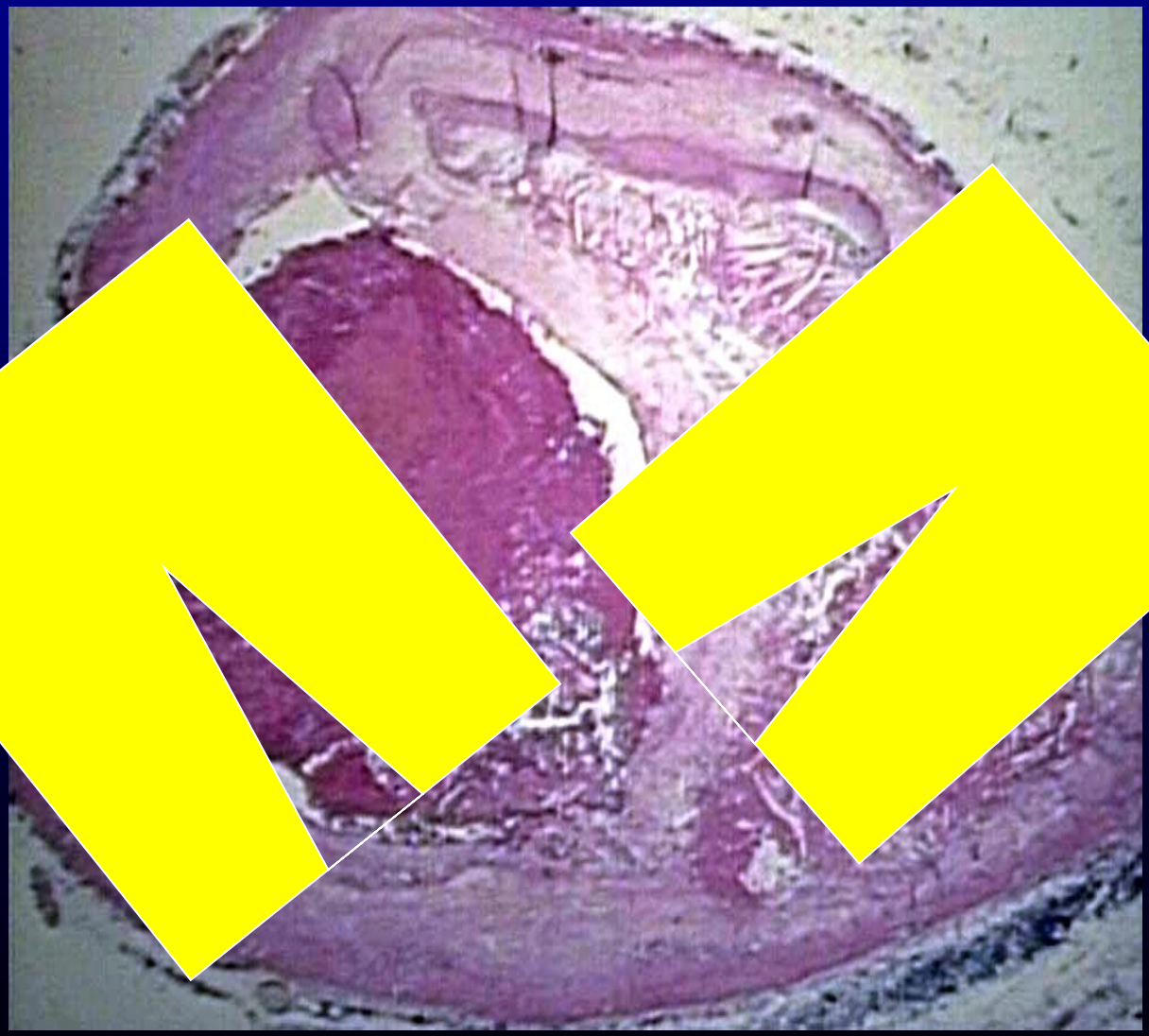
Evolution of Atherosclerosis



Rupture of Fibrous Cap

- *Pro-thrombotic core exposed to lumen*
- *Acute thrombosis*
- *Embolization of plaque materials and thrombus*

In situ thrombosis



Clot

Atherosclerotic Plaque

Clot forms in a previously diseased artery

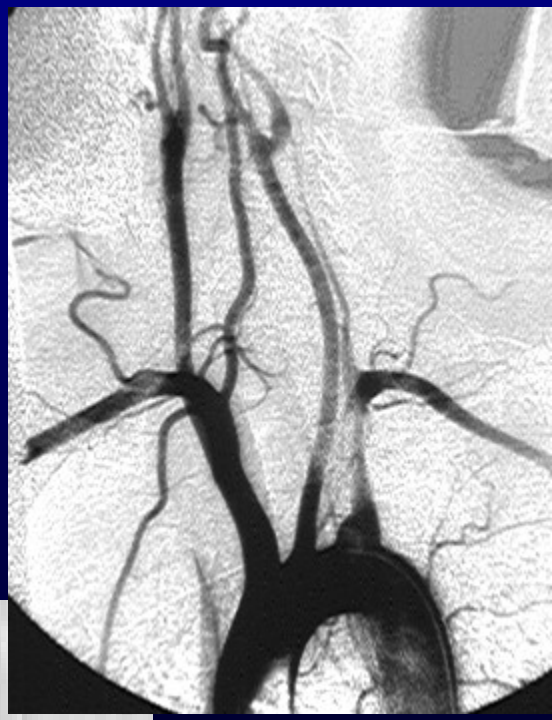
Thromboembolism

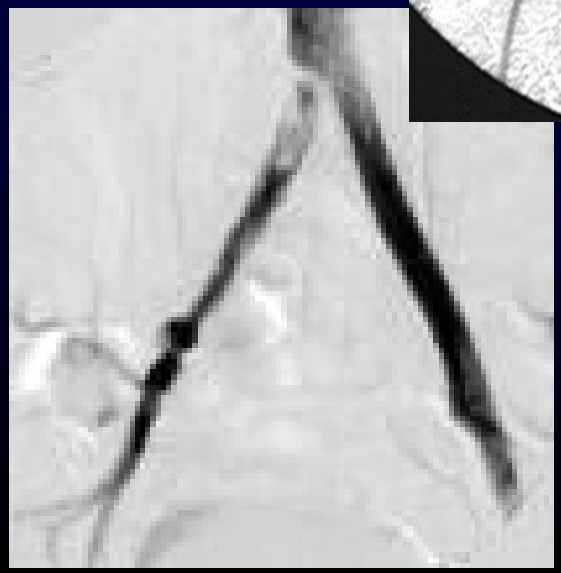
- Embolus-greek“embolos”means *projectile*
- Mortality of 10-25%
- Mean age increasing –70 years
  –Rhumatic disease to atherosclerotic disease
- Classified by size or content
  –Macroemboli and microemboli
  –Thrombus, fibrinoplatelet clumps, cholesterol

Macroemboli

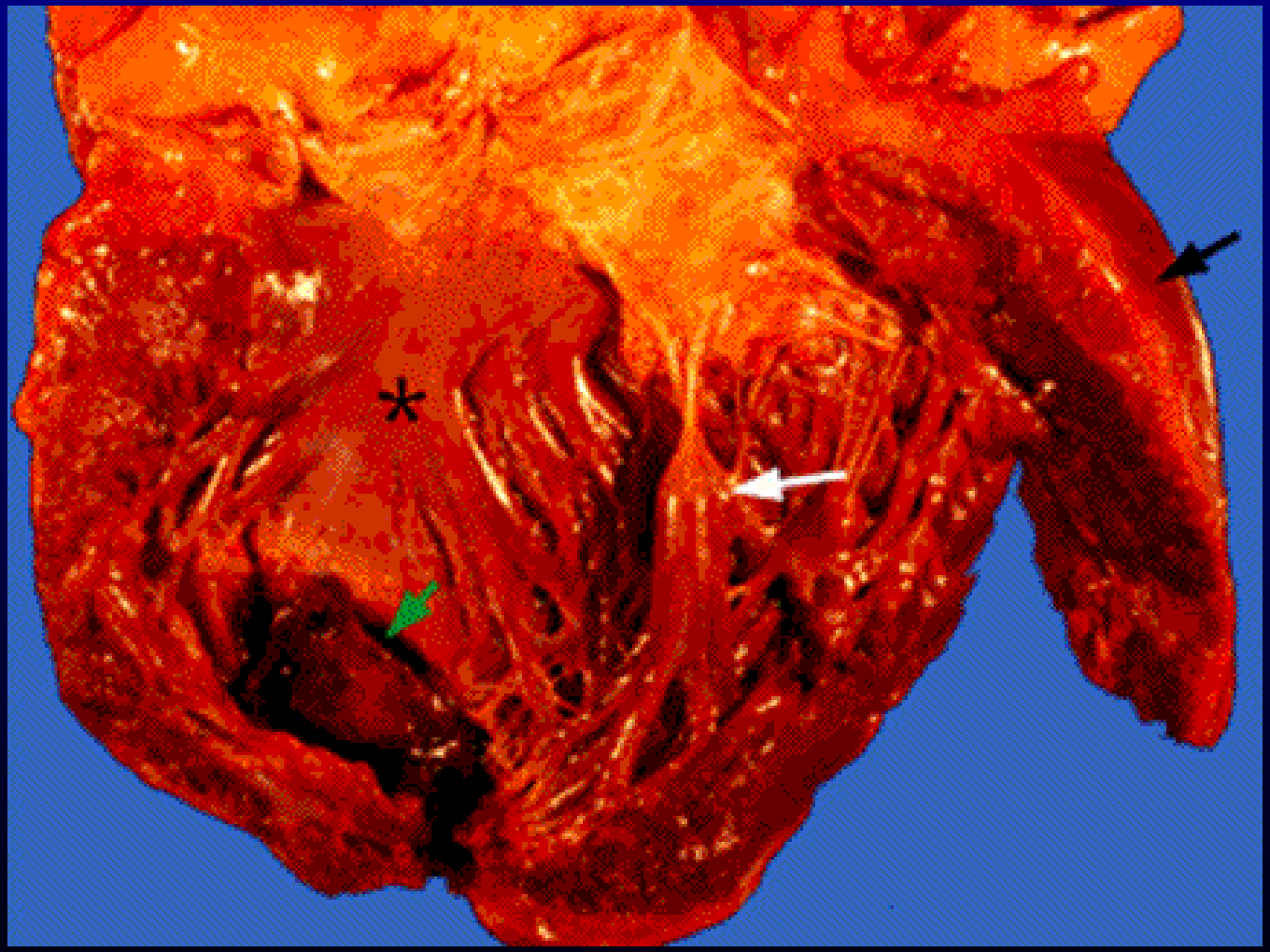
Cardiac Emboli

- Heart source 80-90% of thrombus macroemboli
- MI, A.fib, Mitral valve, Valvular prosthesis
- Multiple emboli 10% cases
- TEE
  - Views left atrial appendage, valves, aortic root
  - not highly sensitive

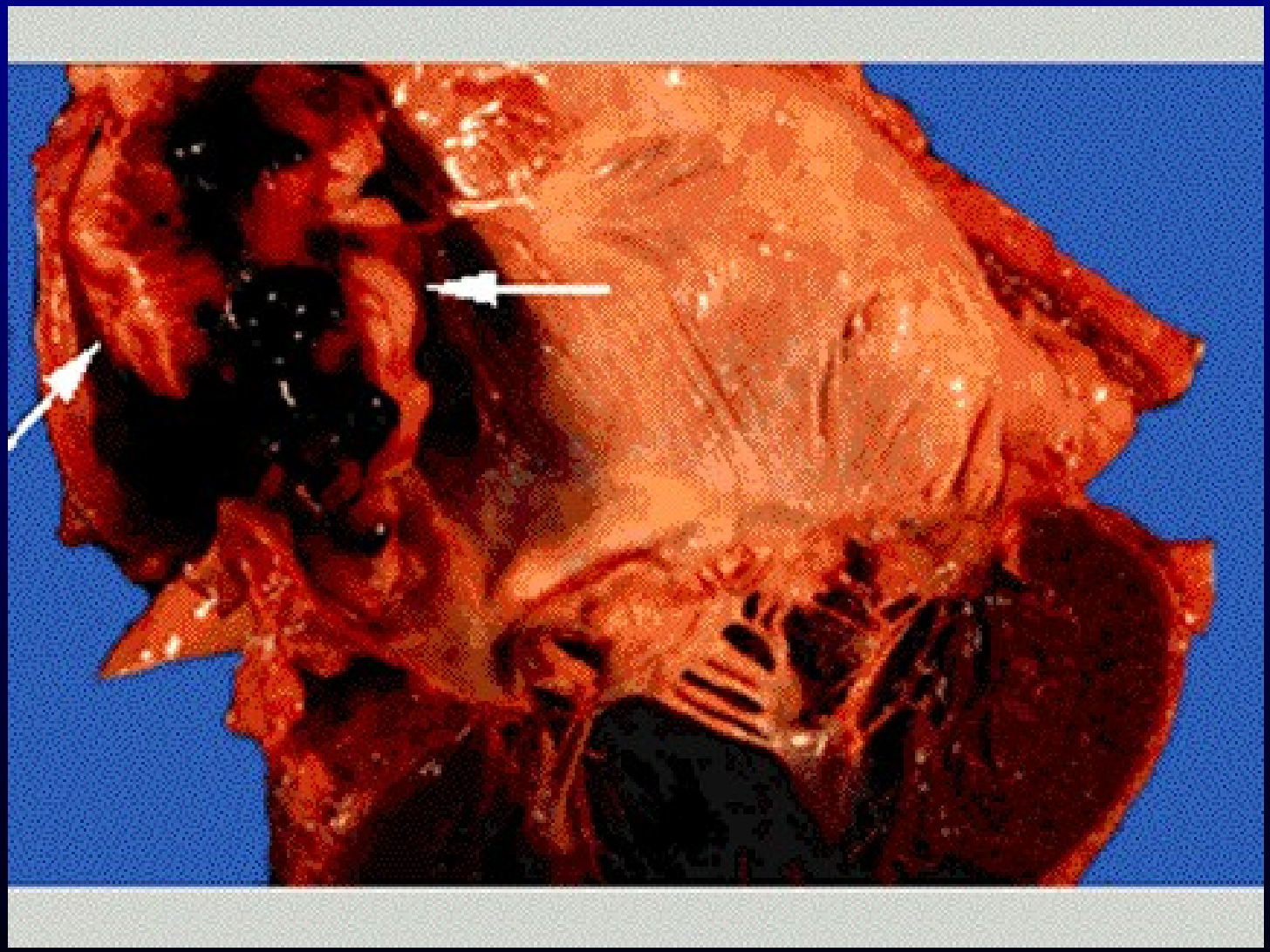




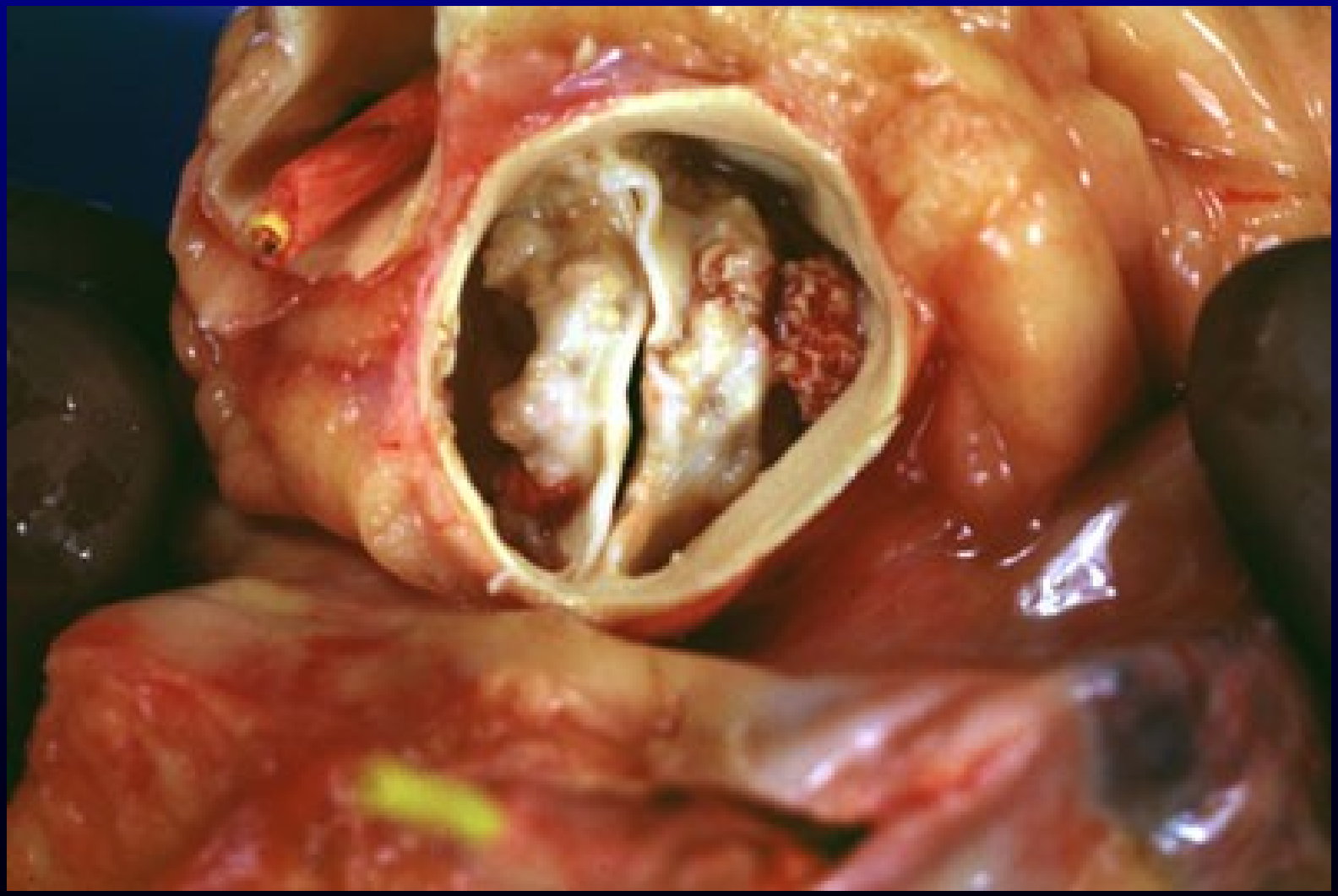
Myocardial infarction and mural thrombosis



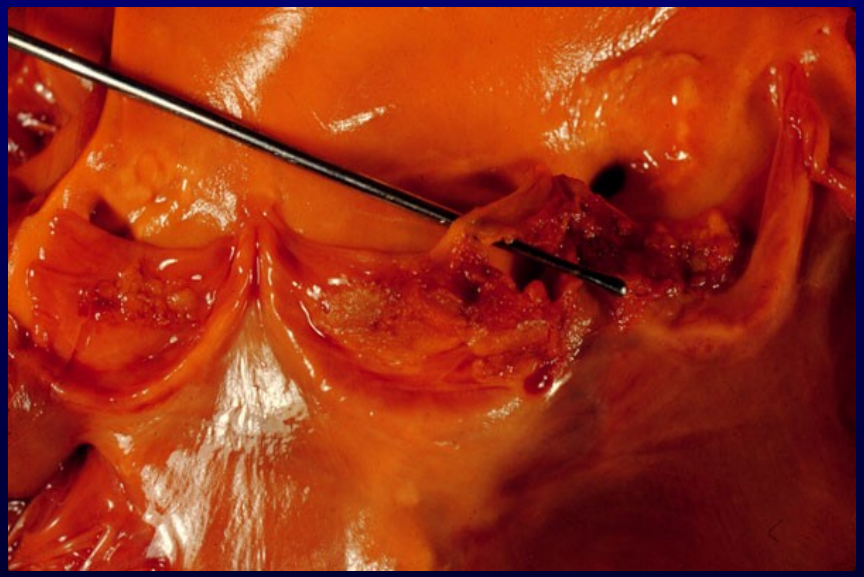
Thrombus in left atrium

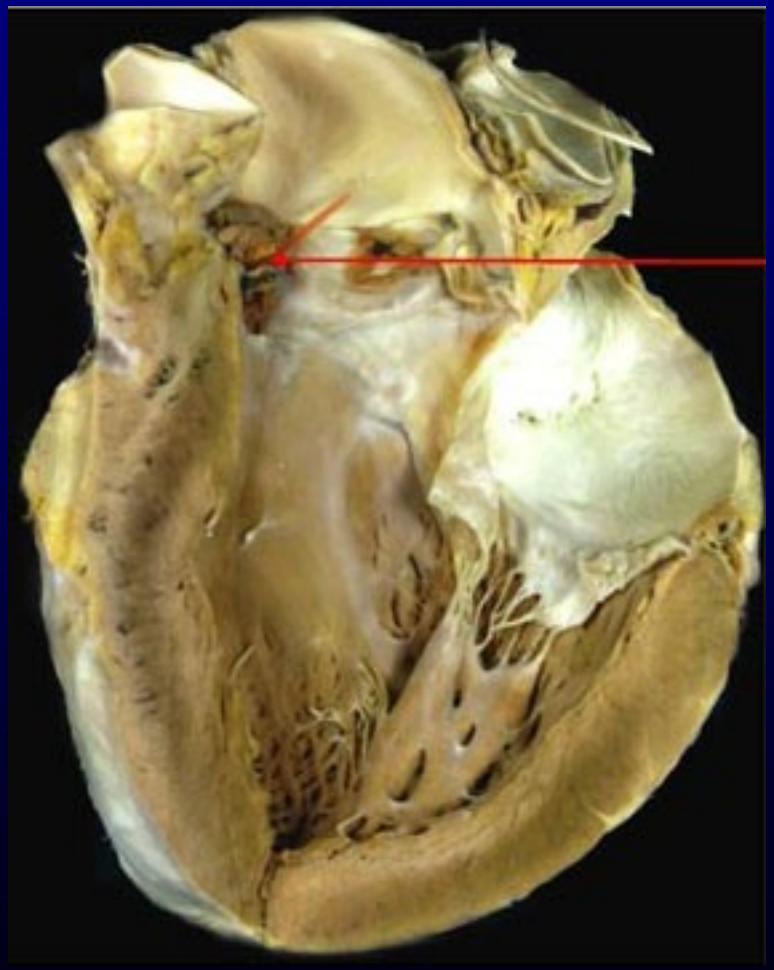


Clot on bicuspid aortic valve



Bacterial endocarditis

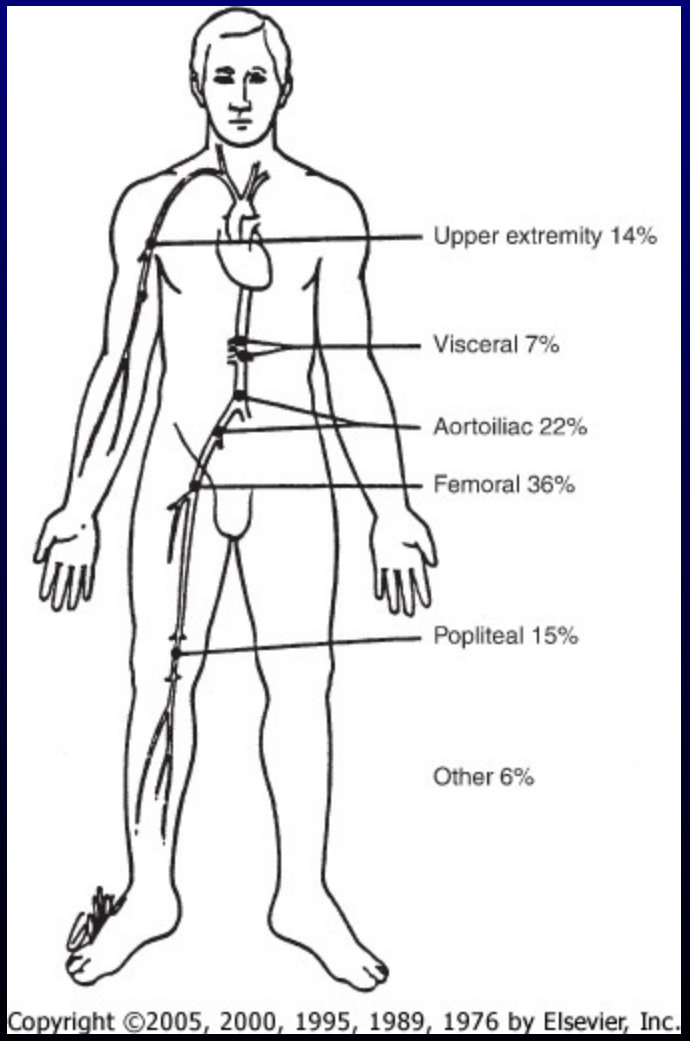




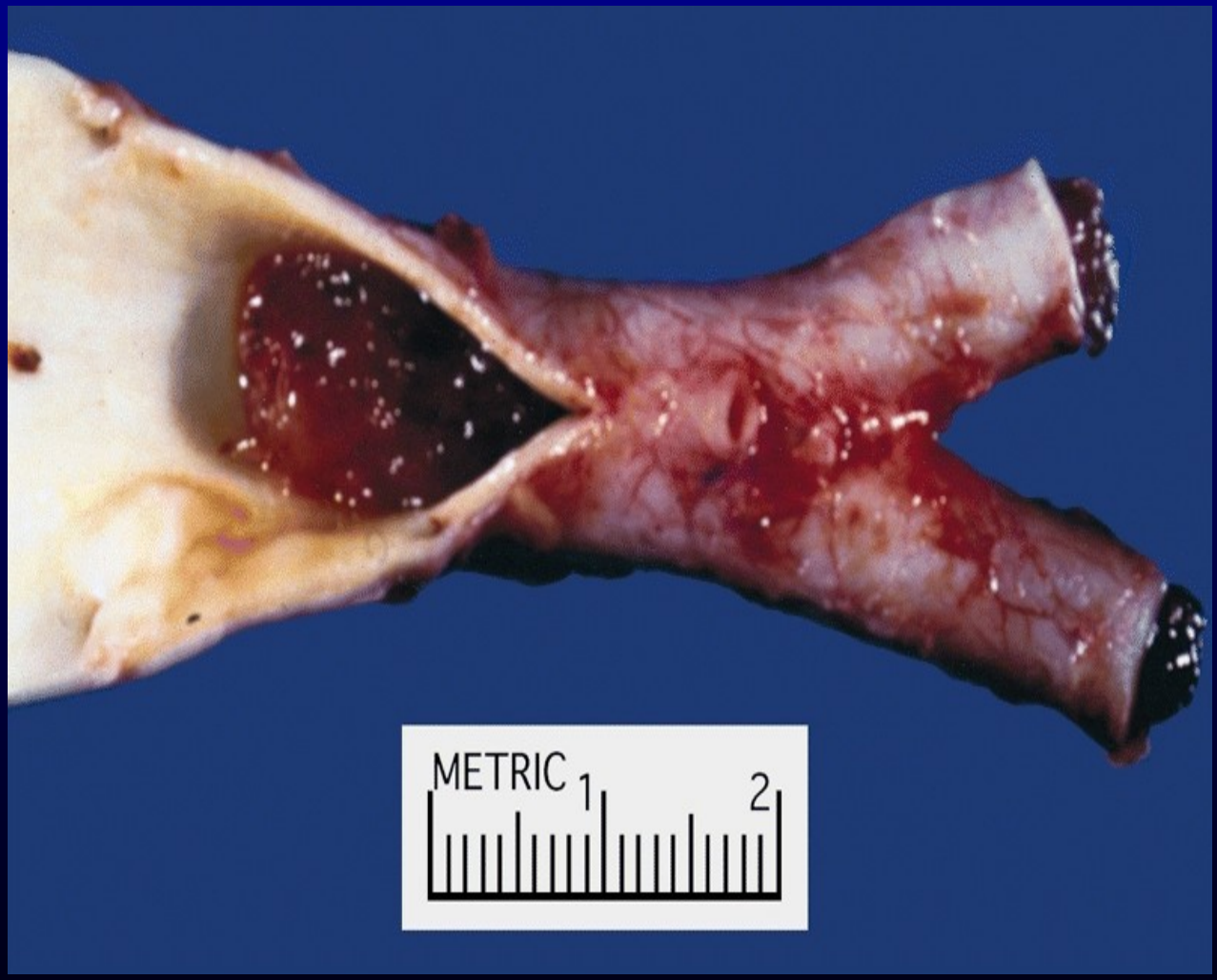
Thromboembolism

- 75% of emboli involve axial limb vasculature
- Femoral and Polilteal

  –>50% of emboli
- Branch sites
- Areas of stenosis



Saddle Embolus in the aorta



Clot breaks off from another location and travels in arteries.

Thromboembolism

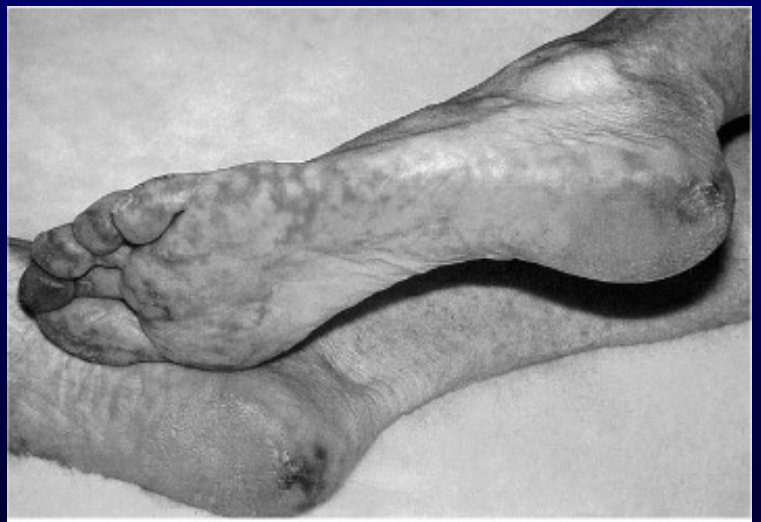
Non-cardiac sources

- Aneurysmal (popliteal> abdominal)
- Paradoxical

  –Follows PE with PFO
- TOS
- Cryptogenic –5-10%
- Atheroemboli (artery to artery)

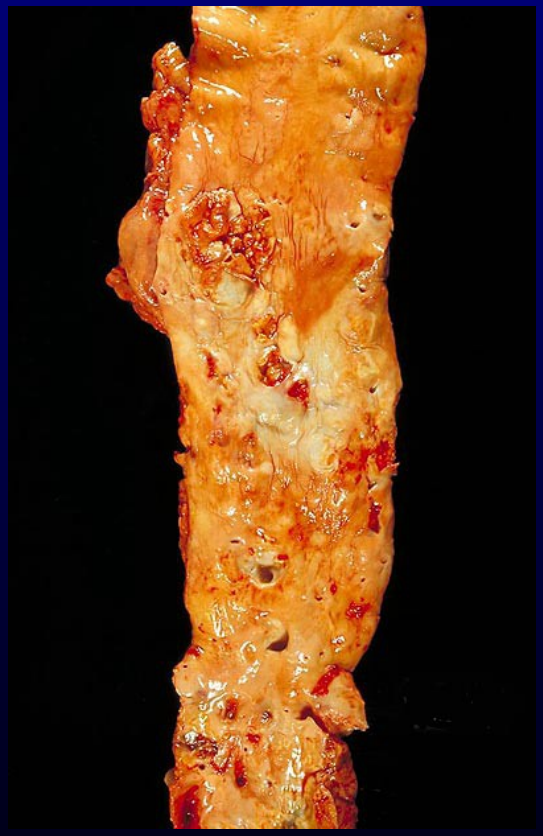
Atheromatous Embolization

- Shaggy Aorta
  - –Thoracic or abdominal
- Spontaneous
- Iatrogenic
  - –45% of all atheroemboli
- "Blue toe syndrome"
  - –Sudden
  - –Painful
  - –cyanotic
  - –*palpable pulses*
- livedo reticularis



Atheromatous Embolization

- **Risk factors: PVD, HTN, elderly, CAD, recent arterial manipulation**
- **Emboli consist of thrombus, platelet fibrin material or cholesterol crystals**
- **Lodge in arteries 100 –200 micron diameter**



Atheromatous Embolization

- Affect variety of end organs

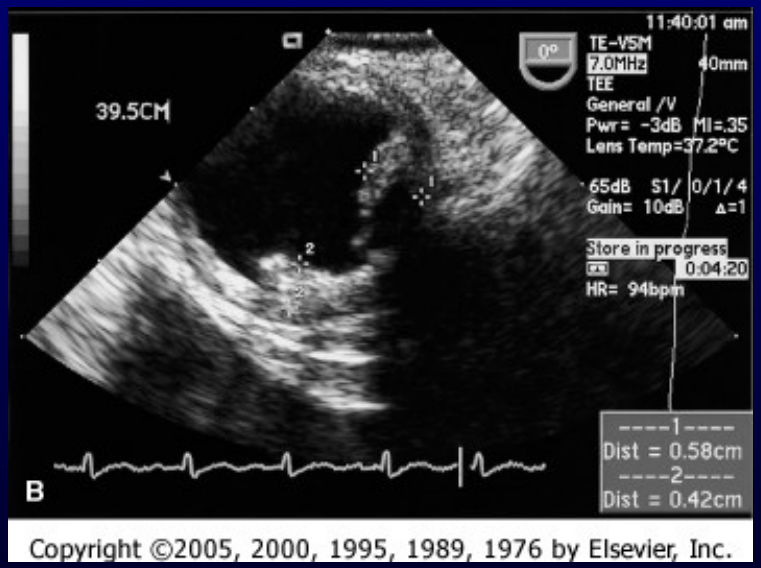
  –extremities, pelvis ,GI, kidney, brain

- Work-up:

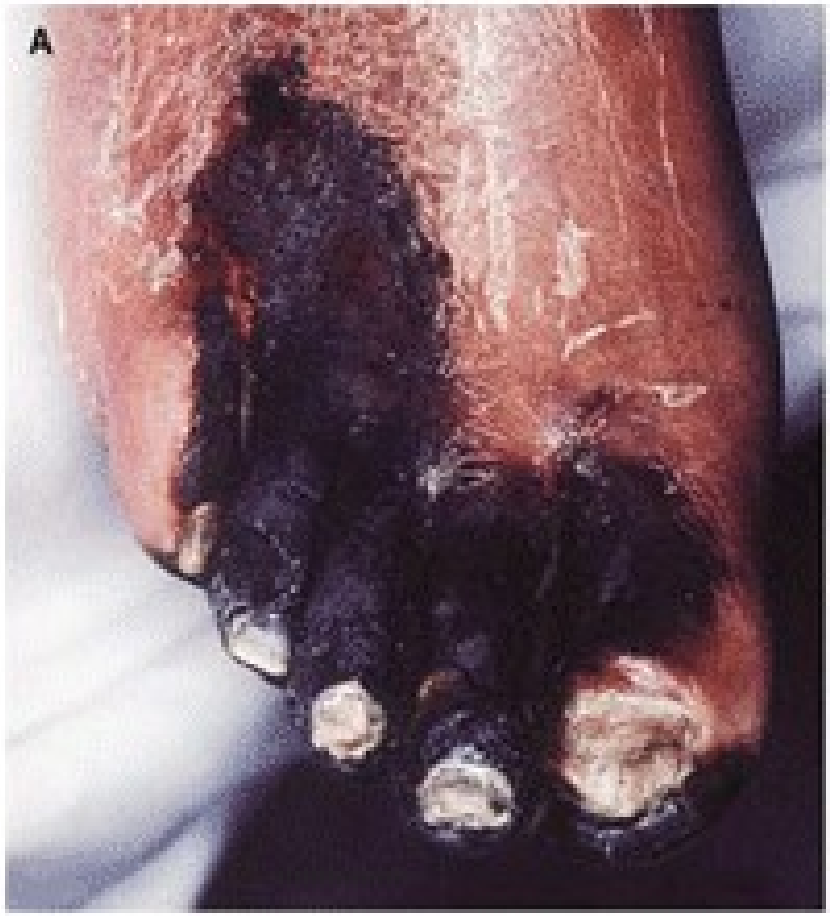
  –TEE ascending aorta, CT Angio, Angiography

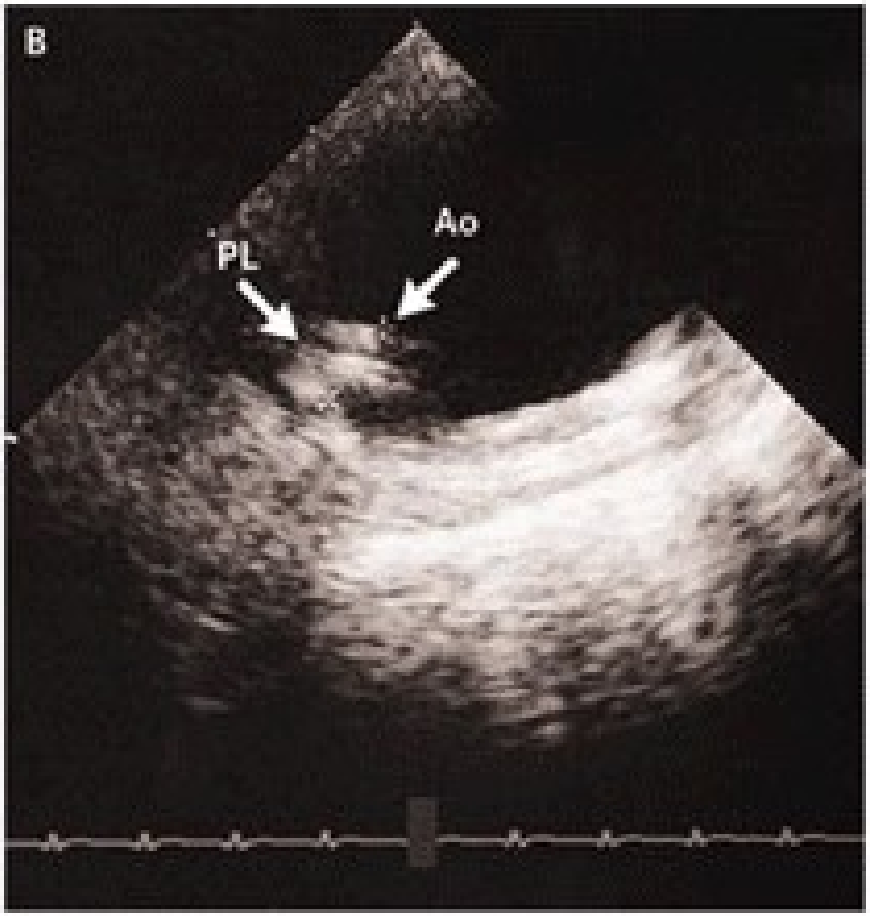
- Laboratory: CRP elevated, eosinophilia

- Warfarin may destablize fibrin cap and trigger emboli



Arterial to arterial embolization





10% of all arterial emboli.

Atheromatous Embolization

- Reported incidence of 0.5-1.5% following catherter manipulation
  - –Advance/remove catheters over guidewire
  - –Brachial access? –controversial

- Limited Sx–Anti-coagulation/ observation
- Temporal delay up to 8 weeks before renal symtoms

Atheromatous Embolization

Therapy

- Prevention and supportive care

  –Statins, prostacyclin analogs (iloprost), ASA, Plavix

- Elimination of embolic source and reestablishing blood flow to heal lesions

- Surgical options: endaterectomy or resection and graft placement

  –Abdominal Aorta –Aorta-bi-fem bypass

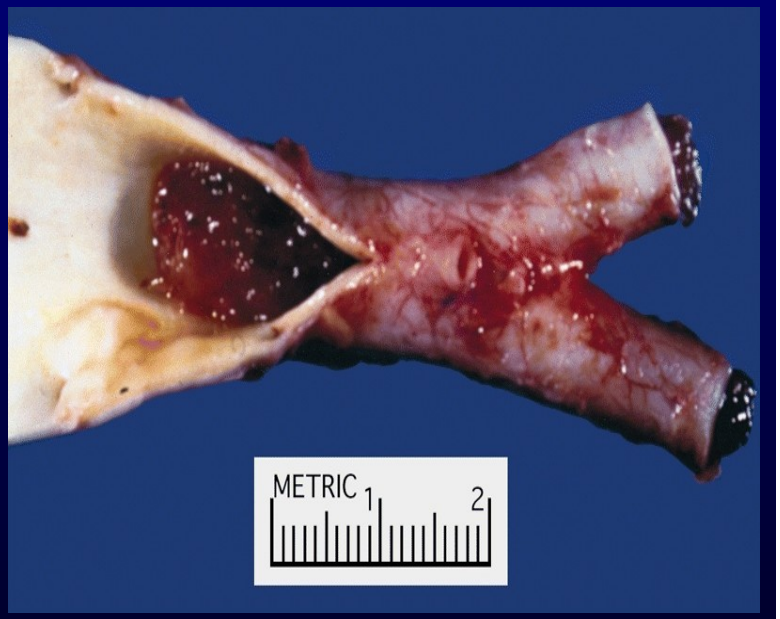
  –Ligation of external iliac and extra-anatomic bypass if high risk

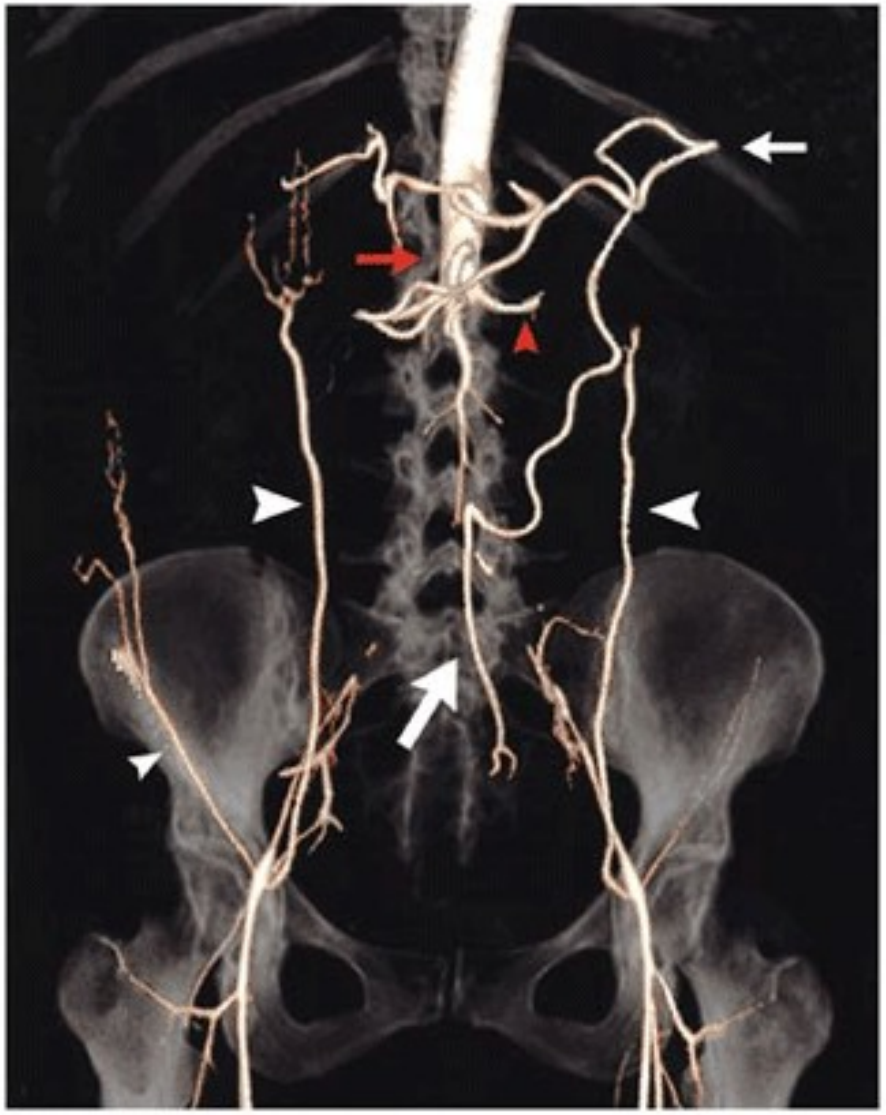
- Endovascular therapy

  –Angioplasty & stenting-higher rate of recurrence

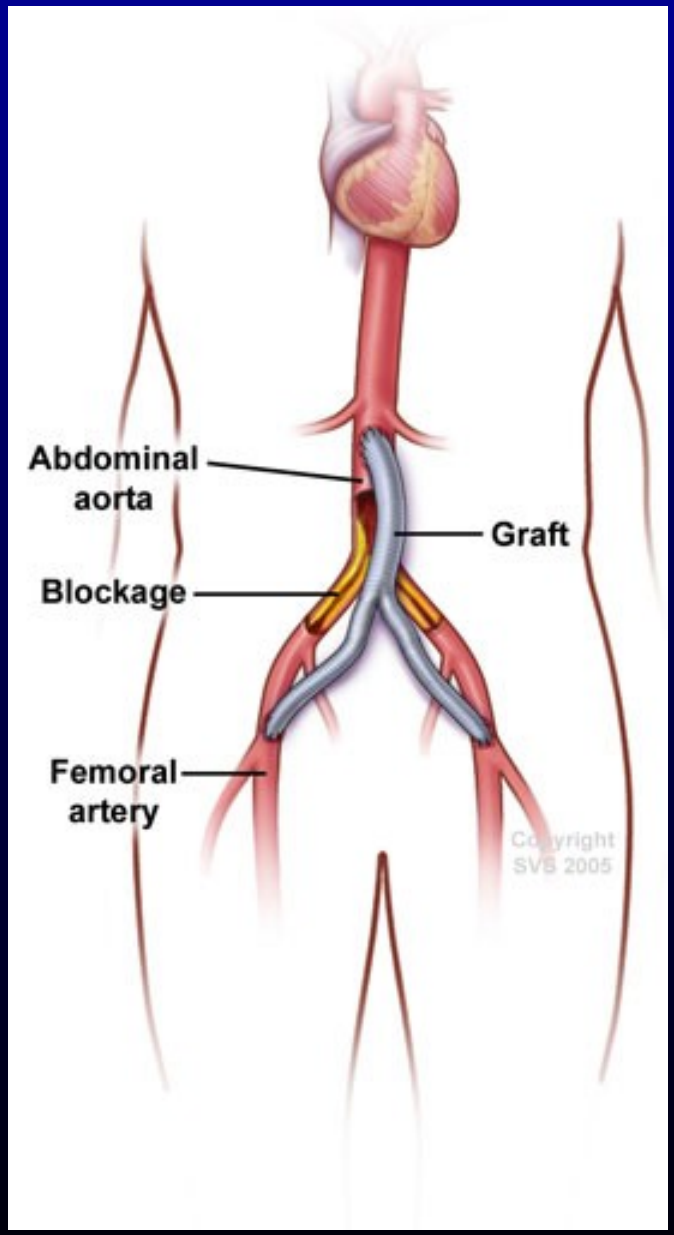
  –Athrectomy–limited data

In situ thrombosis - aortic occlusion





Aorto-bifemoral bypass



Acute Thrombosis

- **Graft thrombosis (80%)**

  –intimal hyperlasia at distal anastamosis (prosthetic)

  –Retained valve cusp

  –Stenosis at previous site of injury

- **Native artery**

  •Intra-plaque hemmorhage

  •Hypovolemia

  •Cardiac failure

  •hypercoagable state

  •Trauma

  Arteritis, popliteal entrapment, adventitial cystic disease

Acute Thrombosis

Heparin Induced Thrombosis -***HIT***

- **White Clot Syndrome**
- **Heparin dependent IgG anti-body against platelet factor 4**
- **3-10 days following heparin contact**
- **Dx: thrombosis with >50% decrease in platelet count**
- **Tx: Direct throbin inhibitors: Agartroban& Hirudin**

  –Avoid all heparin products
- **Morbidity and Mortality: 7.4-61% and 1.1-23%**

Other causes of Thrombosis

- Anti-thrombin III Defiency
- Protein C & S Defiency
- Factor V Leiden variant
- Prothrombin20210 Polymorphism
- Hyper-homocystinemia
- Lupus Anti-coagulant (anti phospho-lipid syndrome)

"The Cold Leg"

- *Clinical Diagnosis*
  - –Avoid Delay
  - –Anti-coagulate immediately
  - –Pulse exam
  - –6 P's (pain, pallor, pulselessness, parathesias, paralysis,poiklothermia)
- *Acute –vs-Acute on chronic*
  - –Collateral circulation preserves tissue
  - –Traditional 4-6 hr rule may not apply

Diagnostic Evaluation

SVS Classification

"Rutherford Criteria"

- ***Class I: Viable***

  -Pain, No paralysis or sensory loss

- ***Class 2: Threatened but salvageable***

  -2A: some sensory loss, No paralysis -No immediate threat

  -2B: Sensory and Motor loss - needs immediate treatment

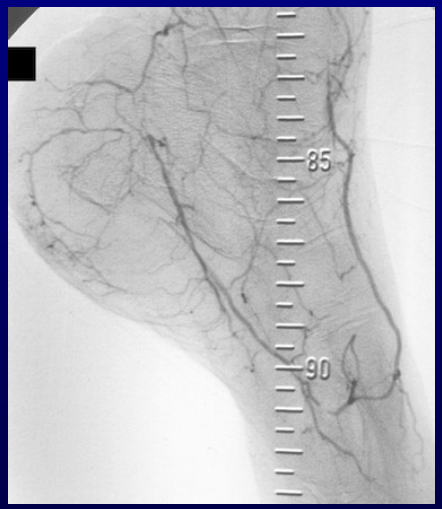
- ***Class 3: Non-viable***

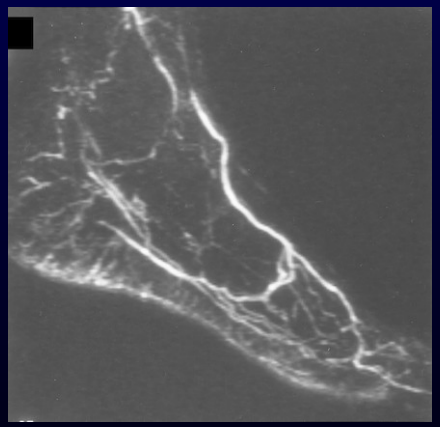
  -Profound neurologic deficit, absent capillary flow, skin marbling, absent arterial& venous signal

Therapeutic Options

- **Class 1 or 2A**
  - **Anti-coagulation, angiography and elective revascularization**
- **Class 2B**
  - **Early angiographic evaluation and intervention**
- **Class3**
  - **Amputation**

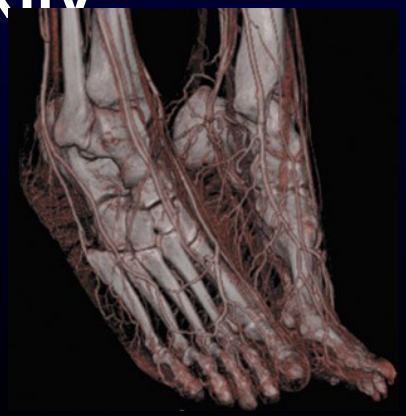
Diagnostic Evaluation



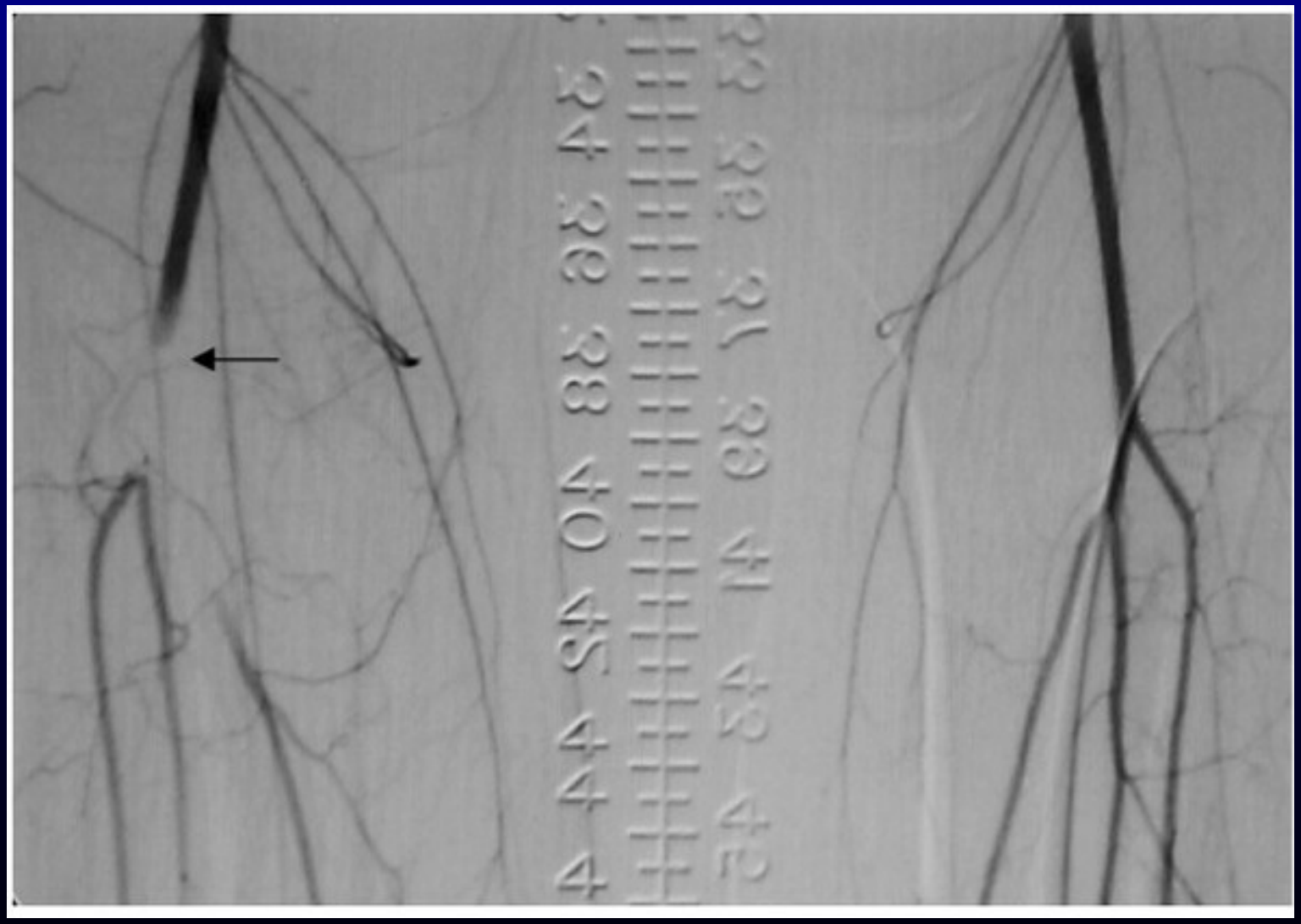


Modalities

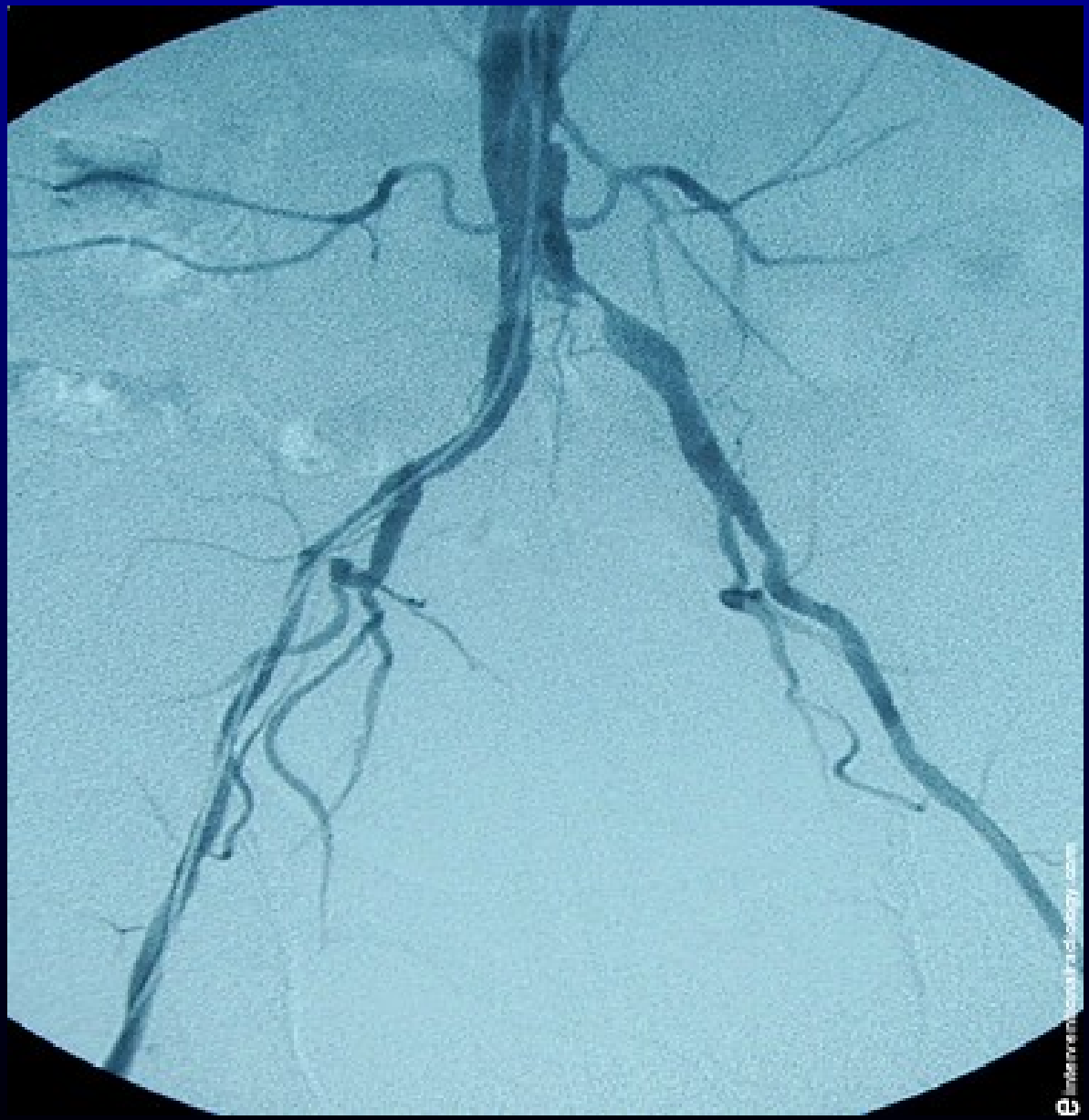
- **Doppler USG-Non-invasive:**
  - **•Segmental pressure drop of 30mmhg**
  - **•Waveforms**
  - **•CTA / MRA : avoid nephrotoxity**
    - **Center dependent**
    - **Wave of the future?**
- **Contrast Angiography**
  - **•Gold Standard**



Embolism – angiographic picture



Iliac stenosis



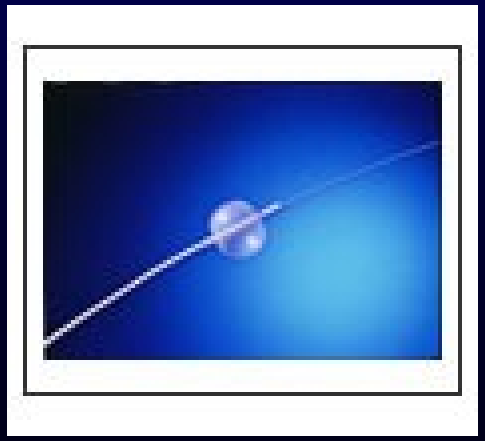
Treatment Options

- Multiple options available
  - –Conventional surgery
    - •embolectomy
    - •endarterectomy
    - •revascularization
  - –Thrombolytic therapy
  - –Percutanious mechanical thrombectomy

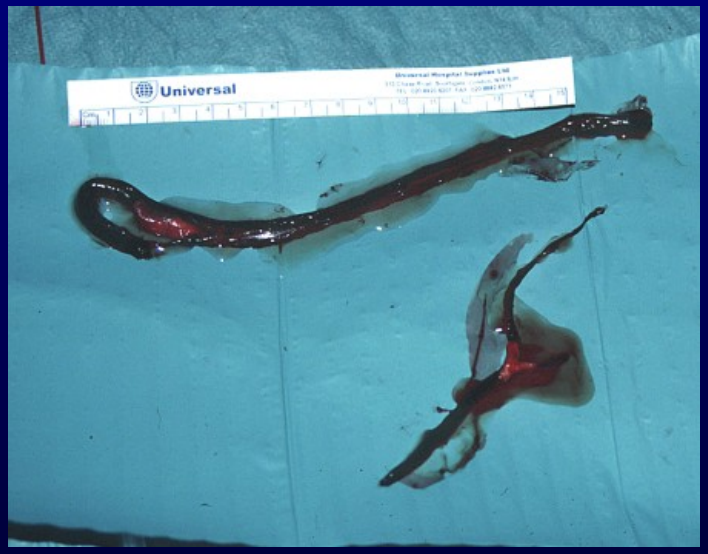
- Native vessel thrombosis often require more elaborate operations

Embolectomy

- Fogarty embolectomy catheter
  - –Intoduced1961
- Adherent clot catheter
- Graft thrombectomy catheter
- Thru-lumen catheter
  - –Selective placement over wire
  - –Administer: lytics, contrast



Embolectomy



Surgical Therapy

- Iliac and femoral embolectomy
  - –Common femoral approach
  - –Transverse arteriotomy proximal profunda origin
  - –Collateral circulation may increase backbleeding
  - –Examine thrombus

Thrombolytic Therapy

- *Advantages*
  - •Opens collaterals & microcirculation
  - •Avoids sudden reperfusion
  - •Reveals underlying stenosis
- *Risks*
  - •Hemmorhage
  - •Stroke
  - •Renal failure
  - •Distal emboli transiently worsen ischemia

Surgery –vs-Thrombolysis

- STILE Trial
- Surgery vsThrombolytics for Ischemia of Lower Extremity
  - –393 pts with non-embolic occlusion
  - –Surgery vs r-TPA or r-UK
- Thrombolytics: improved amputation free survival and shorter hospital stay (0-14 days)
- Surgery: revascularization more effective

Surgery –vs-Thrombolysis

TOPAS Trial

- **2 phase**
- **544 patients**
- **r-UK vs Surgery**
- **Need for surgery Reduced 55%**
- **Similar amputation and mortality rates**

NEJM 338, 4/16/98

Indications for Thrombolysis

Category 1-2a limbs should be considered

–Class 2b : Two schools of thought

- 1)"Delay in definitive Tx"
- 2)"Thrombolytics extend window of opportunity"

- Clots <14days most responsive

–But even chronic thrombus can be lysed

- Large clot burden

Technique of Thrombolysis

- Catheter directed delivery
  1)Lace clot via catheter with side holes
  2)Pulse-Spray technique (mechanical component)

- Urokinase and TPA equally effective

- 4 hr treatment followed by angiogram
  –no improvement after 4hr >> surgery
  –Continue Heparin
  –Fibrinogen levels

Mechanical Thrombectomy

- ***Percutaneous aspiration embolectomy***

  –Viable alternative in selected patents

  –Varity of devises

  –Combines diagnostic and therapeutic procedure

  –Removes non-lysable debris

  –Effective in distal vessels

  –Risk distal embolization

  - **Combine with lyticTx**

Reperfusion Syndrome

- Ischemic-reperfusion syndrome
  - –**Local:** endothelial damage, capillary permeability, Transudative swelling, cellular damage
    - •Compartment Syndrome
    - •Tx: Fasciotomy
  - –**Systemic:** Lactic Acidosis, Hyperkalemia, Myoglobin, Inflammatory Cytokines
    - •Cardiopulmonary complications
  - –Renal Tubular necrosis
    - •Myoglobin precipitates
    - •Tx: Volume, Urinary alklinization

Summary

- **Thrombotic and embolic occlusions are separate processes with different presentations and treatments**
- **Treatment pathways in AAO are complex and vary depending on clinical situation**
- **Catheter-based treatments preserve outcomes with less overall morbidity**