432 Surgery Team

4 Atherosclerosis: A Surgical Look

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COLOR GUIDE: • Females' Notes • Males' Notes • Important • Additional

Objectives

Not Given

ATHEROSCLEROSIS

What is Atherosclerosis?

It is an inflammatory process that causes clogging, narrowing and hardening of the large and medium sized arteries.

Risk factors ⓘ

❖ Non-Modifiable Risk Factors:

1. Male gender
2. Advanced age
3. Family history

Note:

The concept you should keep in your mind that atherosclerosis is one disease, one group of symptoms and one treatment. But different arterial trees are affected so patients will present with different symptoms

❖ Modifiable Risk Factors:

- **Major**

1. Smoking
2. Hypertension
3. Diabetes
4. Hyperlipidemia

- **Minor**

1. Homocystenemia
2. Obesity
3. Hypercoaguable state
4. Physical inactivity .

Note:

Homocystenemia *(RARE condition): accumulation of homocysteine = Increases the viscosity of the blood which will induce Atherosclerosis. (Treatment: Folic acid)*
Hypercoaguble state: *(Decrease amounts of Protein C, S and Antithrombin III. So they should be measured especially in young patients)*

Pathogenesis

- The key word in Atherosclerosis is inflammation.
- Fat deposits accumulate and will cause endothelial injury that will initiate the inflammatory process.
- Formation of fibrous plaque by platelets.
- Calcification of the arterial wall (this is the cause of atherosclerosis).
- Fat by itself is NOT harmful but it is the rupture of the plaque.
- Rupture of the wall will cause clotting (atherothrombosis). From YOUR MANUAL TO SURGERY 351 BY RASLAN

IMPORTANT NOTES FROM EXTERNAL RESOURCES

	Notes
PRINCIPLES AND PRACTICE OF SURGURY, 6th Edition BY DAVIDSON'S	The clinical manifestations of arterial disease depend upon: • The site of the disease • Whether the artery is an end-artery or well collateralized • The speed with which the disease develops • Whether the underlying process is primarily hemodynamic, thrombotic, atheroembolic or thromboembolic, or due to aneurysmal dilatation or dissection • The presence of other co-morbidity and the general condition of the patient.

Clinical Spectrum

- Cerebrovascular disease
- Coronary artery disease
- Renal artery Diseases (hypertension)
- Visceral arterial disease (mesenteric)
- Peripheral arterial disease most common
    - Intermittent claudication
    - Critical limb ischemia

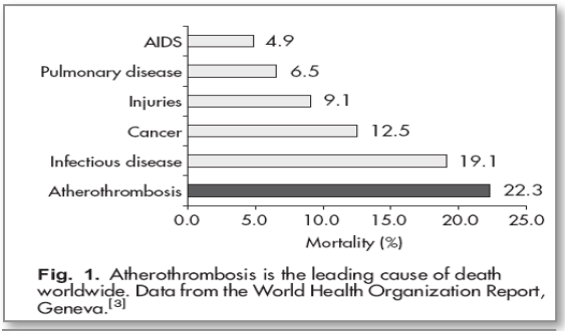


Fig. 1. Atherothrombosis is the leading cause of death worldwide. Data from the World Health Organization Report, Geneva.[3]

It is number one killer worldwide and here in Saudi Arabia and it predicted to increase.

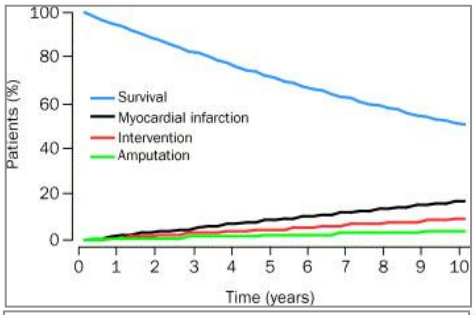
Note:

Visceral arterial disease: (Mesenteric): *Patient's main symptom: pain when eating so it's usually mistaken with peptic ulcer. Patient will also tell you he's afraid to eat because of the pain and is losing weight as a consequence. Investigations include CT angiography to make sure it's an arterial disease.*

Peripheral Arterial Disease:

Why it is important to recognize patients with PAD?

- PAD is a marker of systemic atherosclerosis.
- Patients with either symptomatic or asymptomatic PAD generally have widespread arterial disease.
- Patients with PAD have the following:
  - ❖ Coexisting disease:
  - ○ 35-92% have coexisting Coronary artery disease (CAD)
  - ○ 25-50% have coexisting Cerebrovascular disease (CVD)
  - ❖ Cause of death in PAD patients:
  - ○ 40-60% die from CAD
  - ○ 10-20% die from CVD
  - ❖ Non-cardiovascular causes: Only 20% to 30 %
- Patients with PAD have a 6 fold increased risk of cardiovascular disease mortality compared to patients without PAD even the patient with or without symptoms.



Natural history ⓘ
- ○ Annual mortality rate is 6.8%
- ○ Annual risk of Myocardial infarction is 2%
- ○ Annual risk of intervention is 1%

Natural History:

- Annual mortality rate is 6.8%
- Annual risk of myocardial infarction is 2%
- Annual risk of intervention is 1%
- Amputation 0.4%

Patient presentation

> ***Note:***
>
> *Almost 80 – 90% of PAD "atherosclerosis" patients are asymptomatic. If you manage to screen high risk groups even if they don't carry symptoms, (e.g. Old age (>50), family history, male) and give them a specific pharmacotherapy (we will talk about it later) you will increase their survival rate and reduce cardiovascular mortality rate.*

Symptomatic ⓘ

- **Intermittent claudication**(Medical Treatment without intervention)

  Definition: Pain at a lower limb group of muscles at exertion that is relieved by rest usually. That pain is caused by lactic acid formation from anaerobic pathway that happens because of decreased oxygen supply "ischemia" .The lactic acid cause irritation to the nerves and pain starts. Most common site is superficial femoral artery that manly supply muscles below the knee (especially calf muscle). When Patient complain about the pain you should as a doctor ask about (Site, Distance, and how is it relived)

- **Critical Limb Ischemia**: Needs urgent intervention
  - ✓ Pain at rest: usually affect distal part of the limb (finger, and toes)
  - ✓ Tissue loss
  - ✓ Gangrene(Dry)

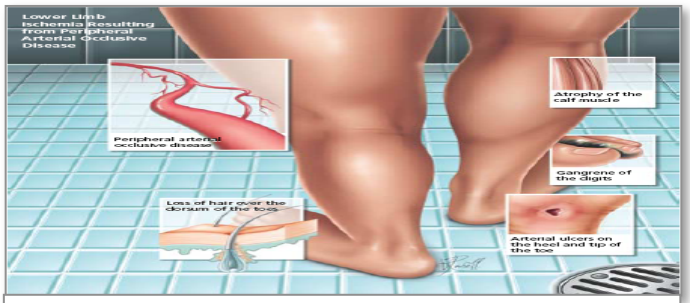
> ***Note:***
>
> *Gangrene in general is usually wet and can be seen in diabetic patents*

Asymptomatic

Diagnosis

Symptomatic

❖ ***History***



1. Atrophy of the affected muscle
2. Peripheral arterial occlusion disease
3. Loss of hair in that area
4. Ulcer in the distal part of the same area because of ischemia
5. Gangrene as an end stage

❖ ***Physical Examination*** *(Inspection and palpation. In PAD, we rarely do auscultation and percussion). When palpating, you move from proximal to distal (Femoral, Popliteal, Dorsalis Pedis, and Posterior Popliteal). This is to know exactly where the atheroma is.*

❖ ***Investigations***

1. They are primarily used for:
2. Confirming the diagnosis after a history and examination and exclude other diseases.

3. Assess severity. From YOUR MANUAL TO SURGERY 351 BY RASLAN.

- **ABI measurement**
- **Non-invasive tests**
  - Arterial duplex Read more
  - CTA (Computed tomography angiography)
  - MRA (Magnetic resonance angiography)
- **Invasive test** (Conventional angiogram). (GOLD standard)

  It is a gold standard but in real life they usually don't use it for diagnosis because it has many side effects which we can divide it to:

  - Local : where you put the needle in :

  1. You can injure the blood vessel causing dissection or occlusion.
  2. Infection
  3. Hematoma
  4. Pseudo aneurysm: it is a hole in the blood vessel so blood comes out and continue to circulate in that hole. It doesn't have a wall, instead it covered by hematoma.
  5. Distal embolization

  - Systematic

  1. Nephrotoxicity
  2. Simple Allergic reaction to Anaphylaxis shock.

  - READ MORE

Asymptomatic

ABI measurement

Ankle Brachial Index

It is the index between the systolic pressure of the Ankle and the brachial systolic pressure.

$$\textbf{ABI} = \frac{\textbf{Highest Ankle SBP (PT or DP)}}{\textbf{Highest Arm SBP}}$$

SBP= systolic blood pressure.
PT= Posterior Tibial artery.
DP= Dorsalis Pedis artery

ABI value	Indicates
<0.9	Abnormal
0.8- 0.9	Mild PAD
0.5- 0.8	Moderate PAD
<0.5	Severe PAD
<0.25	Very Severe PAD

The ABI has limited use in evaluating calcified vessels that are not compressible as in Diabetics.

Notes:

- *In patient with long-standing diabetes and chronic renal failure the ABI is not reliable as the arteries often calcified and hence difficulty to compress. This results in falsely high values. We can measure toe blood presser it should equal to 70 mmHg.*
- *Normal ABI = 1*

Goals of treating patients with PAD

- Relief symptoms
- Improve quality of life
- Limb salvage
- Prolong survival

Strategies in treating patients with PAD

❖ **Risk Factors Modification**

- Diet and weight control
- Exercise (To induce angiogenesis)
- Antiplatelet
- Hypertension control
- Diabetes control
- Lipid control
- Smoking Cessation

❖ **Improve Lower Limb Circulation**

- Conservative (Exercise Program)
- Intervention (Revascularization)

✓ Angioplasty +/- Stenting

Percutaneous Transluminal Angioplasty "PTA"

✓ Surgical Bypass

Notes:ⓘ

Risk factor modification: we give a pharmacotherapy that helps in decrease the morbidity.

- *Antiplatelet as aspirin*
- *Lipid control: Statin anti-cholesterol agent that has anti-inflammatory effect on atherosclerosis and decrease its progression. Regardless whether the cholesterol is high or not in that patient.*
- *Hypertension control: giving small dose long acting ACE inhibitor "lisinopril" as anti-hypertension and anti-inflammatory. Regardless whether the patient is hypertensive or not.*

Improve Lower Limb Circulation:

- *Exercise program to promote angiogenesis and growth of collaterals around the ischemic area.*
- *Intervention: manly surgeons don't intervene with patient who have Intermittent claudication or critical LI unless there is sever ulcer, gangrene, or disable LI"pain with distance <100m".*

❖ **Major amputation** Affects function: Whole leg amputation

- Primary amputation (we start with amputation)
- Secondary (we start with angioplasty or bypass but the patient does not respond)

❖ **Minor:** Doesn't affect function

- Below Knee Amputation vs. Above Knee Amputation.

Carotid Artery Disease:

Why it is important to recognize patients with CAS?

Stroke is the **third** leading cause of death and a principal **cause of long-term disability** in much of the western countries. (Prevention is MORE IMPORTANT than treatment)

Patient presentation

- **Symptomatic**
  - Transient Ischemic Attacks (TIA) "<24 hours of symptom"
  - Amurosis Fugax (Transient unilateral visual loss). This happens if the plaque goes to the ophthalmic artery.
  - Stroke ">24 hours of symptom"
- **Asymptomatic (Most of the patients)**

Diagnosis

- **Symptomatic**
  - Same as PAD
- **Asymptomatic**
  - Carotid Bruit using stethoscope.
  - Arterial duplex (Rare cases)
    - Stenosis is determined by measuring Velocities NOT anatomical diameter.
    - Most common site of atherosclerosis in carotid artery is in the carotid bifurcation.

Goals of treating patients with CAD

- Prevent Stroke
- Prolong survival

Strategies in treating patients with CAD

- **Risk Factors Modification**
  - Diet and weight control

- Antiplatlets
- Exercise
- Hypertension control
- Diabetes control
- Lipid control
- Smoking Cessation

- **Improve Brain Circulation**

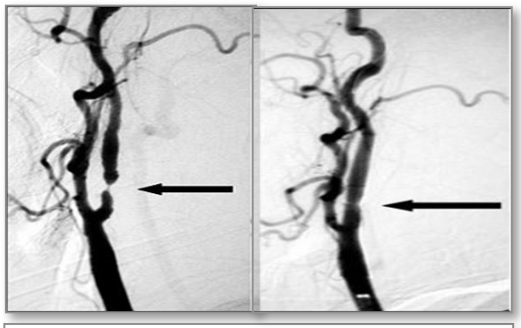
- Intervention (Revascularization)
- Carotid Endarterectomy (Best Method): A surgery to remove plaque buildup in the carotid arteries. READ MORE
- Angioplasty +/- Stenting: has a 7% risk of the plaque breaking up and going to brine circulation and causing stroke.

Indications to intervene:

Symptomatic	Asymptomatic
• > 70% stenosis- NACET • Decrease Stroke at 2 years from 26% to 9% • 50-69% stenosis- marginal benefit, greater for male • Recovered Ischemic Stroke Patients	• > 60% stenosis- ACAS • Decrease Stroke at 4 years from 11% to 5% (should be done in high volume centers only) • If the chance of preoperative stroke >3% don't do the surgery.

Carotid Angioplasty and Stenting

- This interventional procedure is currently under investigation
- Relative Indications
  - Hostile Neck
  - Hostile Carotid Disease
  - As part of a Randomized Clinical Trial



Carotid Angioplasty and Stenting

Acute Limb Ischemia

What is Acute Limb Ischemia?

- Sudden decrease or worsening in the limb perfusion causing a potential threat to the limb viability resulting from a sudden obstruction of the arterial system

Causes of acute arterial occlusion

- Embolus. Most common cause.
  - ➢ Most common artery blocked: Common Femoral
- Thrombosis
- Others

Trauma
Iatrogenic
Arterial dissection

Notes:

ALI differs from PDA by:

- ***The symptom:***
  - *In PDA there is Intermittent Claudication*
  - *In ALI it is sudden, sever with no previous symptom.*
- ***The cause:***
  - *In PAD atherosclerosis.*
  - *In ALI embolism…etc.*

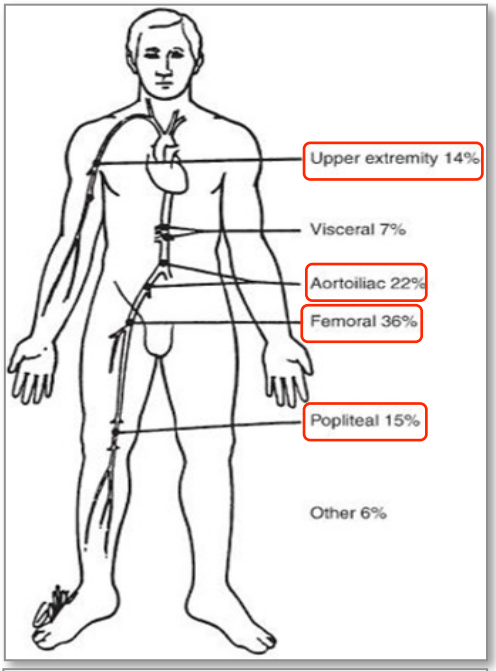
Also, in PAD there is time to develop collaterals (Angiogenesis) while in ALI there isn't.

Possible source for an embolus

- **Spontaneous (80%)**
  - Cardiac source (Most common source)
  - ✓ Arrhythmias, MI, prosthetic valve, endocarditis
  - Non-Cardiac source
  - ✓ Proximal AS plaque, Proximal Aneurysm, Paradoxical emboli

Iatrogenic (20%)

- Angiographic manipulation
- Surgical manipulation



Common sites for embolus lodgment in the arterial tree

Patient presentation

❖ Sudden onset of diffuse and poorly localized leg pain.

❖ 6Ps

- Paresthesias
- Pain
- Poikilothermia (Inability to regulate body temperature; feeling cold)
- Pallor
- Pulselessness
- Paralysis. It usually happens in the end.
- This 6P's usually happens within 6 hours.

> ***Note:***
>
> *The 6p's are for Acute Limb Ischemia and NOT for Peripheral Arterial Disease*

Investigation

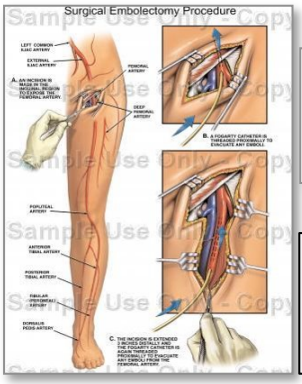
- Acute Limb Ischemia is a *CLINICAL DIAGNOSIS*
- If time allows, especially if atherosclerotic thrombosis is suggested, preoperative angiography is often wise.

Goal of treating patients with Acute Limb Ischemia

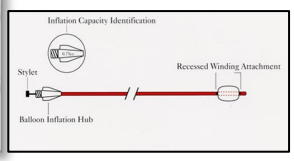
- Rapid restoration of adequate arterial perfusion without the development of morbid local or systemic complications

Treatment

EMEGENCY (Golden time is 6 hours):
ABC (airway, breathing and circulation)
IV Heparin (anticoagulation)
Rapid surgical thromboembolectomy
+/ - surgical bypass
+/- Thrombolytic therapy (we don't use it anymore)
+/- Primary amputation.



Surgical Thrmboemblectomy Procedure



What do we worry about after revascularization?

Reperfusion syndrome:

- **Local**: compartment syndrome, veins and nerves.

Compartment syndrome:

- It is a condition where the pressure inside the compartment rises due to edema after the ischemic injury.
- The raise in pressure will stop the blood flow to the area and cause more ischemia.
- Needs emergency fasciotomy. (4 compartment fasciotomy)

- **Systemic**: Hyperkalemia, Acidosis "due to lactate accumulation" and Myoglobulinurea.

Note:ⓘ

When compartment syndrome happens and ischemia occurs, the muscle will eventually die. When that happens, its' components will go out of it and into the blood circulation. These include: Potassium, Myoglobin and Lactic acid. As a consequence, hyperkalemia (leads to heart failure), myglobinuria (leads to acute renal injury) and acidosis occur.

Treatment of these consequences:

***Hyperkalemia**:* Calcium Gluconate *to protect the heart,* Insulin & Glucose *to shift the potassium from extracellular to intracellular, and sometimes* hemodialysis*.*
***Acidosis**:* Bicarbonates
***Myoglobinuria**:* Diuretics and a lot of fluids.

SUMMARY

1. Atherosclerosis:

It is an **inflammatory** process that causes clogging, narrowing and hardening of the large and medium sized arteries. There are non-modifiable risk factors “male, elderly, family history” and modifiable major and minor risk factors. It causes vascular diseases most common Peripheral arterial disease and cerebrovascular disease.

2. Peripheral arterial disease:

PAD is a marker of systemic atherosclerosis. Patients with PAD have a 6 fold increased risk of cardiovascular disease mortality compared to patients without PAD. Patient presents with **intermittent claudication**, and **critical limb ischemia**. Diagnosis using ABI measurement, Arterial duplex, angiogram “gold standard”. Strategies in patient treatment (Risk Factors Modification, Improve Lower Limb Circulation, amputation).

3. Carotid Artery Disease:

It causes stroke, and it’s the 3rd leading cause of death. Patient presents with Transient Ischemic Attacks, Amurosis Fugax, or Stroke. Diagnosis using ABI measurement, Arterial duplex, and carotid Bruit. Strategies in patient treatment (Risk Factors Modification, Improve Brain Circulation).

4. Acute Limb Ischemia

Sudden decrease or worsening in limb perfusion. Most common cause is Embolus “Cardiac source”. Patient present by sudden onset of diffuse and poorly localized leg pain. 6 Ps

1. Paresthesias
2. Pain
3. Poikilothermia (coolness)
4. Pallor
5. Pulselessness
6. Paralysis.

Acute Limb Ischemia is a clinically diagnosed. The aim of treatment is to Rapid restoration of adequate arterial perfusion. Treatment is an emergency (Golden time is 6 hours) Need Rapid surgical Thromboemblectomy.

Questions

1) All of the following are signs of critical limb ischemia except:
   a. Intermittent claudication
   b. Pulselessness
   c. Poikilothermia
   d. Paresthesiasis

2) All of the following can happen in reperfusion injury except:
   a. Acidosis
   b. Compartment syndrome
   c. Hyperkalemia
   d. Hyperglycemia

Answers:

1. A
2. D

From 431 team work

1- male, above 45 with one risk factor came to primary clinic for Regular checkup, no symptoms of PAD, what should you do?

First we do ABI test then if we find ABI result < or = 0,9. We give pharmacological therapy (1- Anti platelets: Aspirin 2- Statins: Zocor, Crestor, Lipitor. 3- ACE inhibitors) + risk factors modifications, no need for intervention. We use percutaneous trans luminal angioplasty or surgical bypass only if he has critical limp ischemia or short claudication distance = less than 100m then he feels the pain.

* If the patient known to have renal artery stenosis we DO NOT give ACE inhibitors!! Because it decrease creatinin clearence

2- Male, above 45 came to the ER at 2 AM complaining of paresthesias and sudden pain in the right leg with signs of Arrhythmia, what should you do? Wait for investigations??!! & lose your 6 golden hours=(

Hell no, it's a diagnosis based on clinical signs. You should examine the leg and compare it to the other one to confirm diagnosis and give the treatment

1- ABC = Airway, Breathing and circulation.

2- IV heparin (anticoagulant).

3- Thromboembolectomy +/- surgical bypass, Thrombolytic therapy, primary amputation.

3- First choice in treating patients diagnosed with CAD?

Carotid Endarterectomy.

4- Most common site for Acute limp ischemia?

Bifurcation of femoral artery.

From Surgical recall book

What is the common theory of how atherosclerosis is initiated?	Endothelial injury → platelets adhere → growth factors released → smooth muscle hyperplasia/plaque deposition
What are the risk factors for atherosclerosis?	Hypertension, **smoking,** diabetes mellitus, family history, hyper-cholesterolemia, high LDL, obesity, and sedentary lifestyle
What are the common sites of plaque formation in arteries?	Branch points (carotid bifurcation), tethered sites (superficial femoral artery [SFA] in Hunter's canal in the leg)
What must be present for a successful arterial bypass operation?	1. Inflow (e.g., patent aorta) 2. Outflow (e.g., open distal popliteal artery) 3. Run off (e.g., patent trifurcation vessels down to the foot)
What is the major principle of safe vascular surgery?	Get **proximal** and **distal** control of the vessel to be worked on!
What does it mean to "POTTS" a vessel?	Place a vessel loop twice around a vessel so that if you put tension on the vessel loop, it will occlude the vessel.
What is the suture needle orientation through graft versus diseased artery in a graft to artery anastomosis?	Needle "in to out" of the lumen in diseased artery to help **tack down the plaque** and the needle "out-to-in" on the graft
What are the layers of an artery?	1. Intima 2. Media 3. Adventitia
Which arteries supply the blood vessel itself?	Vasovasorum
What is a true aneurysm?	Dilation (> 2× nL diameter) of all three layers of a vessel
What is a false (pseudo)aneurysm?	Dilation of artery not involving all three layers (e.g., hematoma with fibrous covering) Often connects with vessel lumen and blood swirls inside the false aneurysm