VASCULAR INJURY

Prof.Moaath ALSmady
The University of Jordan

Edited by : Haya Khader

OUTLINE

DIAGNOSTIC MODALITIES

COMPLICATIONS

COMPARTMENT

ANATOMIC EXPOSURE

FEMORAL Vs

POPLITIAL Vs

SHANK Vs

PEREPHIRAL VASCULAE INJURY

- Distal to Deltopectoral Groove
- Distal to Inginal ligament
- Hard signs of Vascular injury needs Surgery

Hard Signs

of Vascular injury needs Surgery

- Observed pulsatile bleeding
- Ongoing heamorrhage with shock — tachycardia / hypotension or any sign of shock
- Arterial thrill by manual palpation — arterial venous fistula
- Bruit over or near the artery
- Abscent distal pulse
- Signs of distal ischemia
- Visible expanding hematoma

Soft Signs

- Significant hemorrhage by History
- Small non expanding heamatoma
- Decreased pulse compared to the contralateral extremity
- Bony injury
- Wound proximity (1 cm from Vs)
- Neurologic abnormality(anatomicaly related nerve)

Hard vs. Soft signs of Vascular injury

Hard signs	Soft signs
Active arterial (pulsatile) bleeding	Minor bleeding
Pulseless/ ischemia no distal pulse / distal ischemia	Injury in proximity to major vessel
Expanding pulsatile hematoma	Small to moderate size hematoma non-expanding
Bruit or thrill	Associated nerve injury
	Ankle Brachial Index ABI < 0.9
Operation Mandatory	***Further W/U***

Doppler ultrasound

non-invasive imaging technique that uses sound waves to assess the flow of blood through blood vessels

or pressure

Ankle Brachial Index

simple, non-invasive test used to assess the circulation and arterial health in the lower limbs. It compares the blood pressure in the ankle with the blood pressure in the arm to check for signs of peripheral artery disease (PAD)

< 0.90 = 87% sensitive, 97% specific for arterial injury

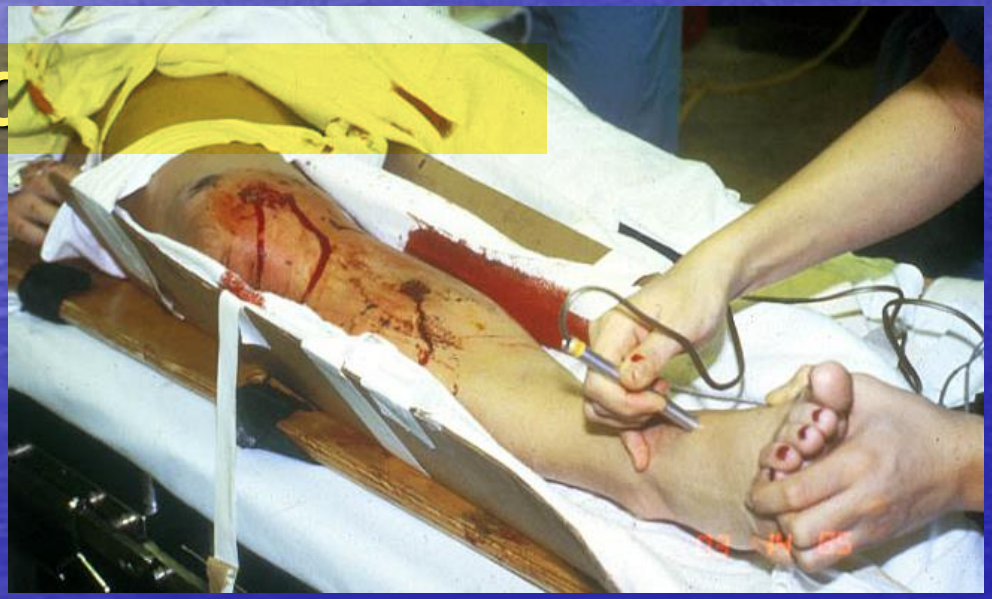
In absence of hard signs, can substitute this for – *screening* arteriography.

Doppler ultrasound

give sound only

- Determine presence/absence of arterial supply
- Assess adec

Assess adequacy of flow



PRESENCE OF SIGNAL DOES NOT EXCLUDE ARTERIAL INJURY !

Imaging Study

Duplex US

non-invasive medical imaging technique that combines two types of ultrasound technology to provide detailed information about blood flow and the structure of blood vessels.

more acudrate
give image and sound

Reliable for

- Injury to arteries and veins
- A-V fistulas
- Pseudoaneurysms
- Thrombosis

*It has 95% sensitivity &99 % specificity

- ***poorly accessible vessels*** :

subclavian, profunda femoris, and profunda brachii arteries

3

Imaging study

CT Angio

-Injection of contrast dye: A contrast dye is injected into a vein (usually in your arm). This dye helps to highlight blood vessels on the CT images.
-CT scanning: As the dye circulates through the bloodstream, the CT scanner (special X-ray machine) takes a series of detailed images, which are then processed to create a 3D image of the blood vessels

* Ct angiograph

faster, less expensive and less invasive

90-100 % sensitivity and 98% - 100 %specificity

* diagnostic study of choice

*Limitations:

- difficulty differentiating spasm from occlusion
- artifact from high attenuation structures like bullet fragments or other foreign matter

Indications for angiography

- Hemodynamic stability
- Uncertain diagnosis
  - Soft signs
  - PVD
- Unclear location
  - Multiple wounds, fractures
  - Shot gun wounds
  - GSW parallel to an artery

gunshot wound

Figure 3. Upper-extremity arteriogram after gunshot wound to the arm with fracture of radius and cutoff of radial artery just below the bifurcation of the brachial artery.

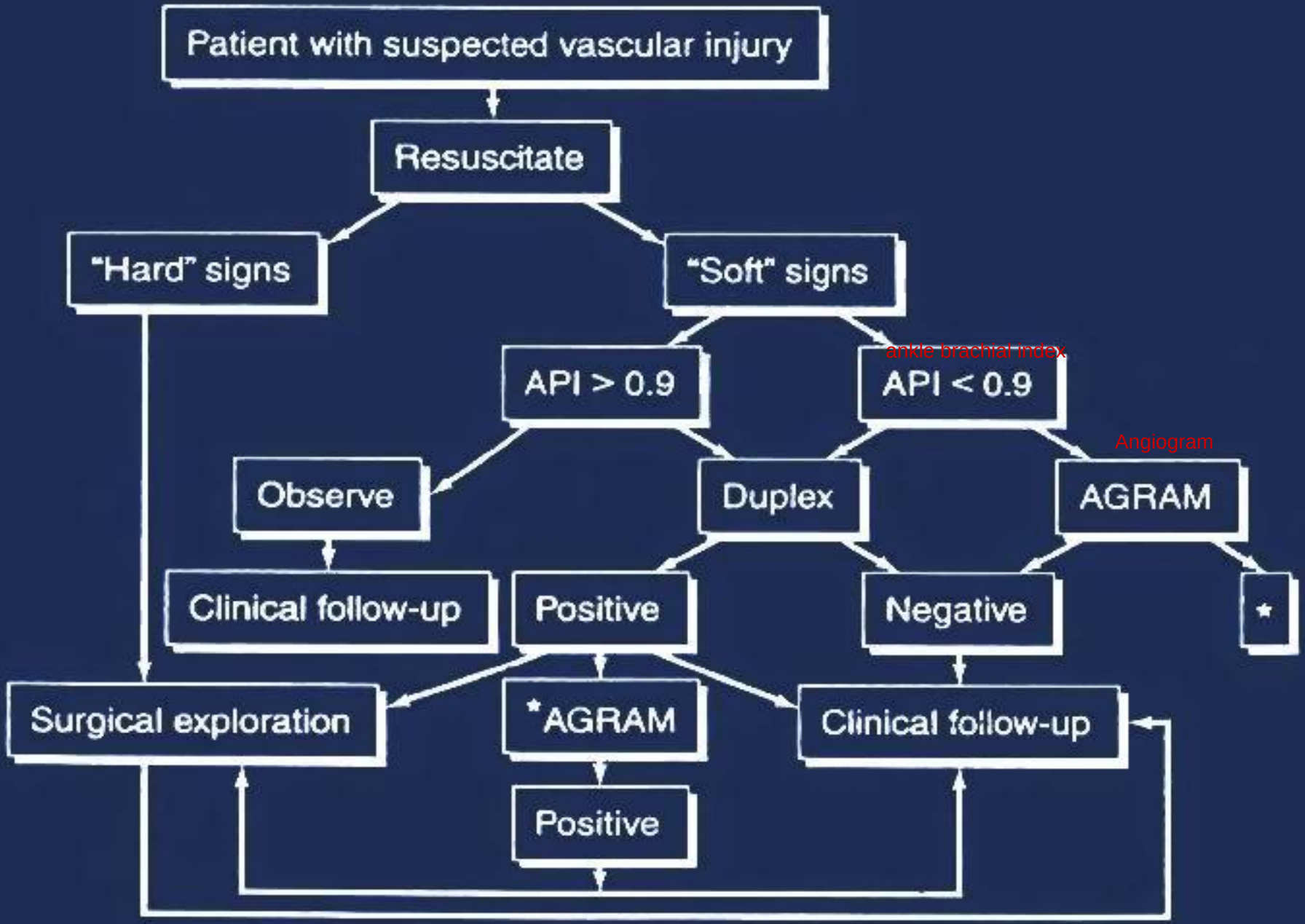

gunshot wound injury of the left subclavian artery
hematoma on suvascular artery

Management

- ABCs
- Active bleeding, limb threatening ischemia → OR
- Stable, good limb viability → may investigate
- Non-operative management → non-occlusive lesion in asymptomatic patient (and no distal ischemia)
- Pre-operative management
  - Prophylactic antibiotic – (contraindications)
  - Single dose heparin iv if no C/I – (preventing blood clots)
- Do not reperfuse dead limb! → amputation

Immediate treatment

- Control bleeding
- Replace volume loss
  - ringer lactate
  - or normal saline if hypotensive
- Cover wounds
- Reduce fractures/dislocations
- Splint


Patient with suspected vascular injury
Resuscitate
"Hard" signs
"Soft" signs
ankle brachial index
API > 0.9
API < 0.9
Angiogram
Observe
Duplex
AGRAM
Clinical follow-up
Positive
Negative
*
Surgical exploration
*AGRAM
Clinical follow-up
Positive

Arterial injuries associated with fractures or dislocations

subclavian artery	Clavicle fracture
axillary artery	Shoulder fx/dislocation
brachial artery	Supracondylar humerus fx
brachial artery	Elbow dislocation
gluteal arteries	Pelvic fracture
iliac arteries	
femoral artery	Femoral shaft fx
popliteal artery	Distal femur fracture
popliteal artery	Knee dislocation
tibial arteries	Tibial shaft fx

Option of vascular repair

Arterial repair:

(1) direct arterial repair — for small to moderate vessel injuries (defect < 1-2 cm) by suturing the edges of the artery together without any additional materials or grafts

(2) arterial patch repair — patch of synthetic material or tissue from another part of the body is used to repair or enlarge a section of the artery that is narrowed or damaged.

(3) interposition graft repair — the use of a graft to replace a damaged section of an artery. The graft is placed between the two healthy ends of the artery, bypassing the damaged area.-

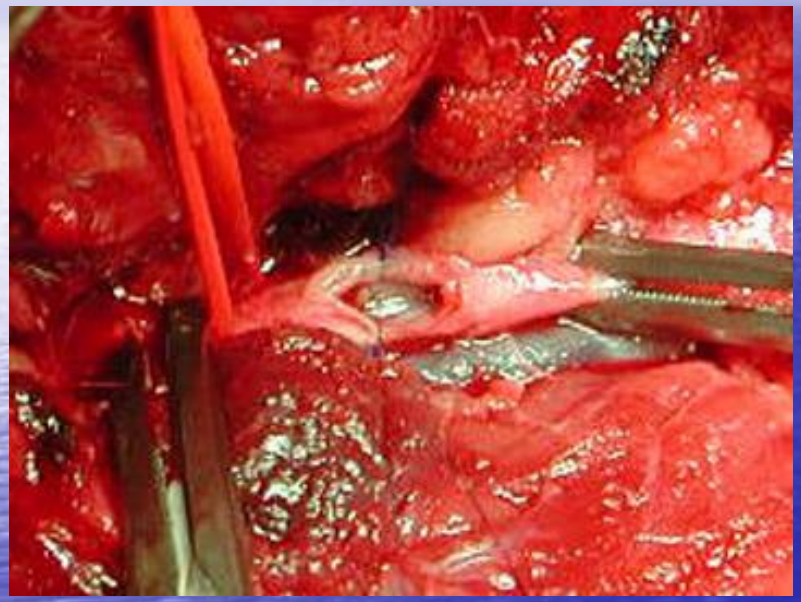
(4) bypass repair — the use of a graft to bypass an obstructed or damaged artery and create a new route for blood flow

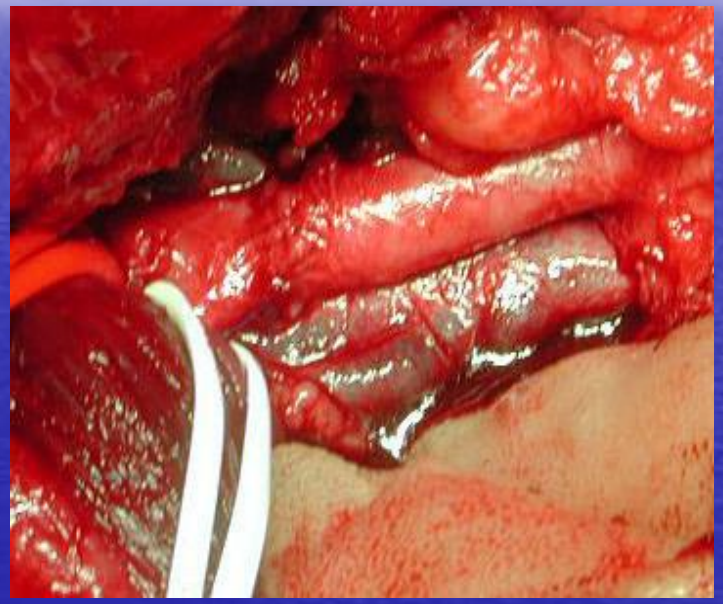
(5) ligation — surgical procedure where an artery or vein is tied off (ligated) to stop blood flow,

Venous repair whenever possible

avoid ligation.

Tension-free primary repair

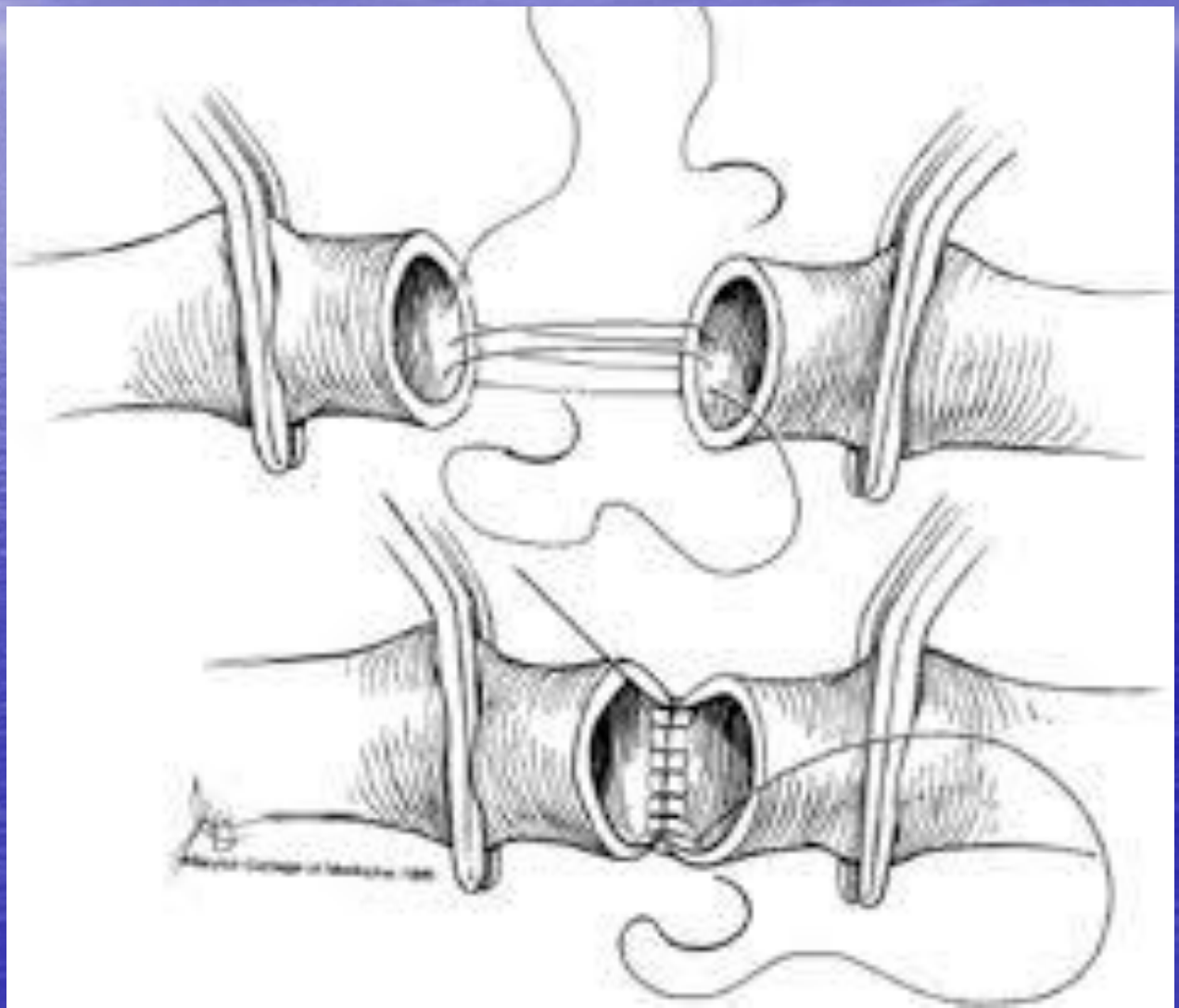




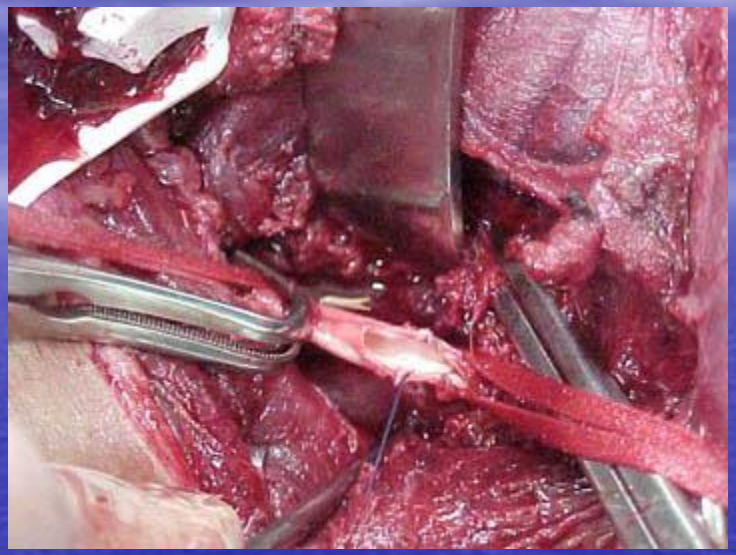
Primary repair → defect < 1-2 cm

loss one third on the artery --> do tension free primary repair (for small defects)

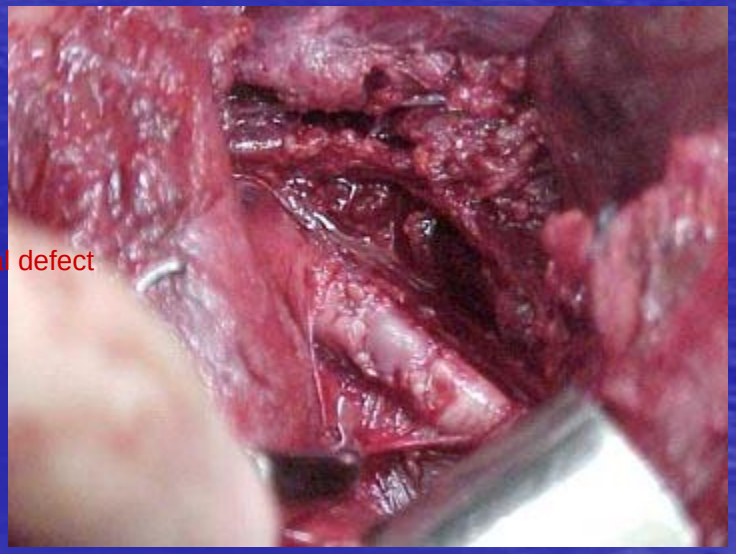
direct arterial repair



Vein patch angioplasty



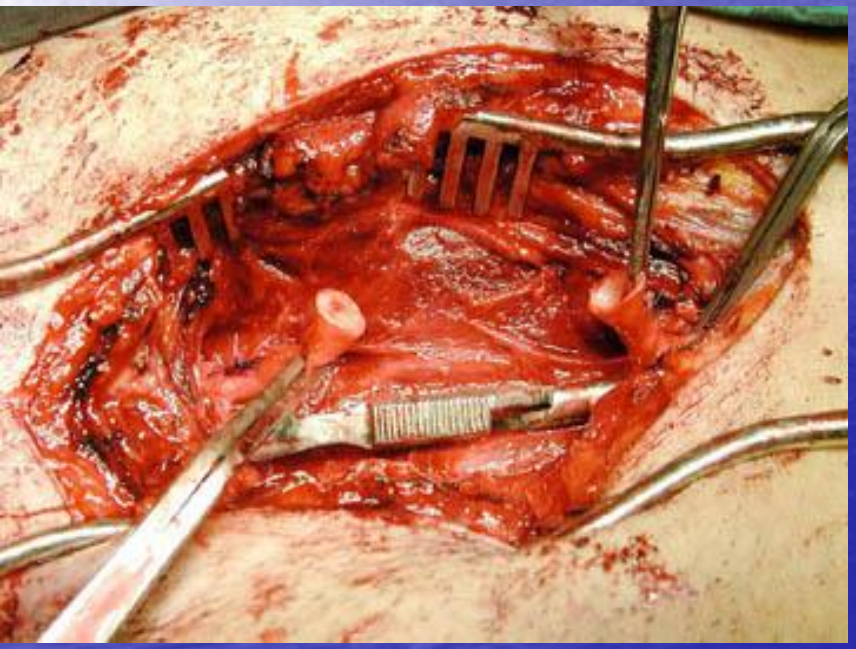
popliteal artery injure



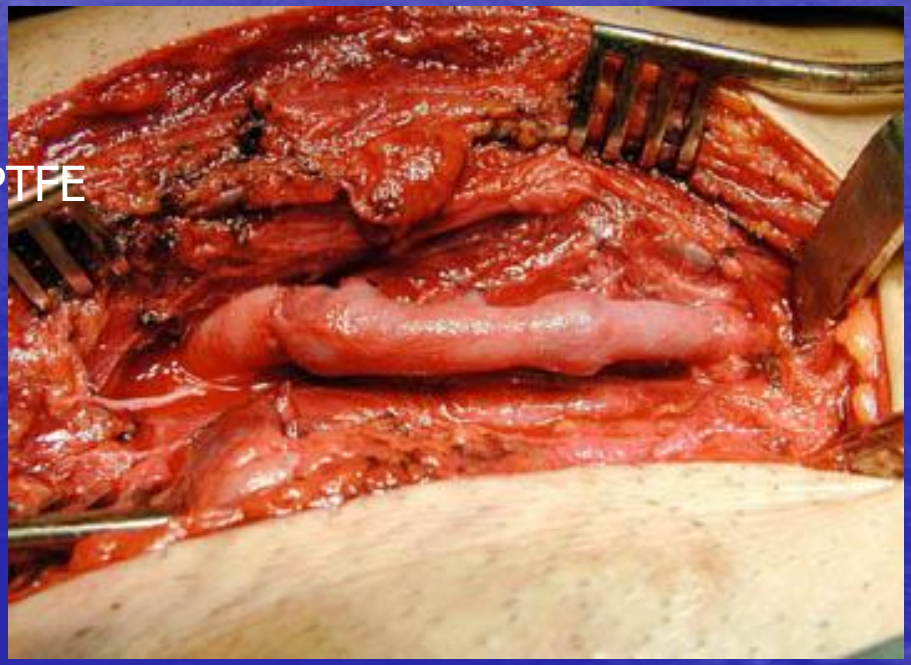
saphenous vein patch clos the popliteal defect

Interposition autogenous vein graft

and connect the two sides of the artery (proximal and distal anastomosis



PTFE



Venous injury

- Should be repaired in stable patient if technically feasible
  - Lateral venorrhaphy, EEA –
  - Complex repair (PTFE, SVG) –
  - Patency 75% –
  - Before arterial repair –

-Lateral venorrhaphy is used for smaller, less complicated venous injuries, where the two ends of the injured vein can be aligned and sutured together.
-End-to-end anastomosis (EEA) is a technique where the two ends of the severed or damaged vein are directly connected.

PTFE (Polytetrafluoroethylene) /saphenous vein grafts (SVG)

Limb threatening ischemia → Shunt a. → repair v.

- Ligation is safe alternative esp. in unstable patients, complex injuries.

What is the management ?

Mangled Upper Extremity

Crush to lower leg

Mangled extremity :injury that involve al least ¾ consisting of bone ,soft tissue ,vessel,nerves

Amputation

- Non-viable or non-salvagable limb
  - –Irreversible limb ischemia
- Safe life before limbs!!!
  - –Amputation can be life saving in life threatening extremity bleeding
- Functional outcome consideration

- **Risk factors for amputation**
- Gustilo III-C injuries ? comminuted, open tib-fib fractures with vascular disruption.
- Sciatic or tibial nerve, or two of the three major upper extremity nerves, anatomically transected
- Prolonged ischemia (>4-6 hours)/muscle necrosis
- Crush or destructive soft tissue injury
- Significant wound contamination
- Multiple/severely comminuted fractures/segmental bone loss
- Old age/severe co-morbidity
- Lower vs. upper extremity
- Apparent futility of revascularization/failed revascularization

-The Gustilo-Anderson Classification is a system used to categorize open fractures based on the severity of the injury, the degree of soft tissue damage, and the involvement of vascular structures
-Type III fractures are characterized by severe soft tissue damage, including extensive contamination, comminution of the bone, and potentially vascular injury.
-III C: The most severe form of open fractures, involving both extensive soft tissue loss and vascular injury

COMPLICATIONS OF VASCULAR INJURY MANAGEMENT

COMPLICATIONS OF VASCULAR INJURY MANAGEMENT

- Hemorrhage
- Thrombosis — most important one / most common complication
  early occlusion rate of 9.1%
- Infection
- Stenosis — technical complication
- Miscellaneous

THROMBOSIS

formation of a blood clot (thrombus) within a blood vessel

- most important complication
- relatively common compared with other complications.
- early occlusion rate of 9.1%,

causes of thrombosis

- Inadequate arterial debridement
- A second adjacent injury
- Residual distal arterial thrombus
- Severe stenosis at the suture line
- Undue tension due to significant missing arterial segment
- Twisting or too long graft to cause a kink or external compression of the graft


A

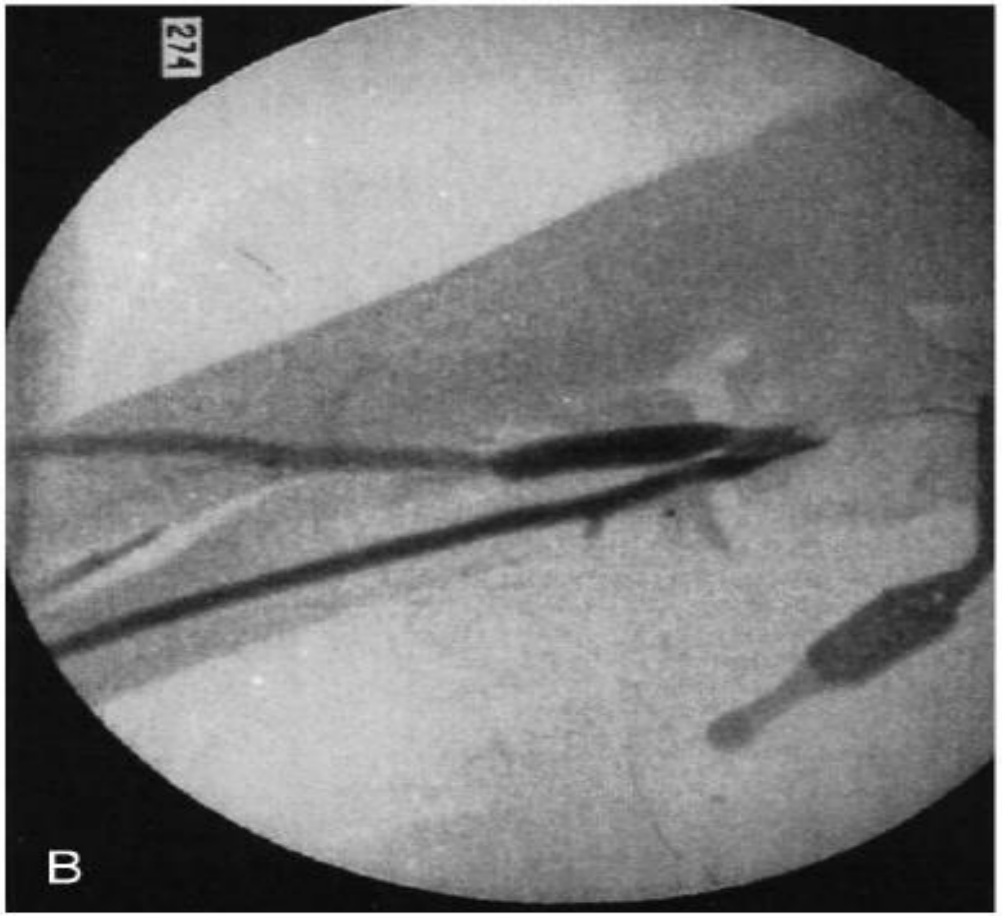


Figure 4. *A*, Completion angiogram after brachial ulnar interposition vein graft. Note the kink in the distal end of the graft secondary to redundancy. *B*, Completion angiogram after revision of the distal anastomosis showing smooth emptying of graft with good runoff by way of the ulnar artery.

2 INFECTION

- Primary skin closure in a war wound
- Placement of a vascular graft in an area of established infection
- Inadequate soft tissue debridement in an attempt to conserve tissue for coverage of a vascular repair
- Inadequate debridement of a damaged vessel

STENOSIS

- Technical complication
- Tight suture repair.
- Lateral repair without sufficient remaining wall
- Residual arterial wall damage.
- Tension on the suture line

lead to fibrosis and stenosis

Figure 12. Arteriogram demonstrating severe stenosis of the proximal anastomosis of an autogenous saphenous vein graft at the right brachial-axillary artery junction which was performed in Vietnam. Although prominent collateral circulation existed between the humeral circumflex and deep brachial arteries, the patient developed discomfort with repetitive motion of his right hand (see Figs. 13 and 14). (*From* Rich NM, Baugh JH, Hughes CW. Significance of complications associated with vascular repairs performed in Vietnam. Arch Surg 100:646–651, 1970; with permission.)

MISCELLANEOUS COMPLICATIONS

Acute

- Errors in diagnosis

second associated or adjacent arterial injury

Improper identification of the arteries may occur

- Edema
- Embolization

medical procedure used to block blood flow to a specific area in the body by intentionally introducing an embolus (a blockage), typically through a catheter, into a blood vessel. It is a minimally invasive technique that can treat a variety of conditions, particularly those involving abnormal or excessive blood flow.

- Disseminated intravascular coagulopathies

due to hypovolemia and bledding

error in diagnosis

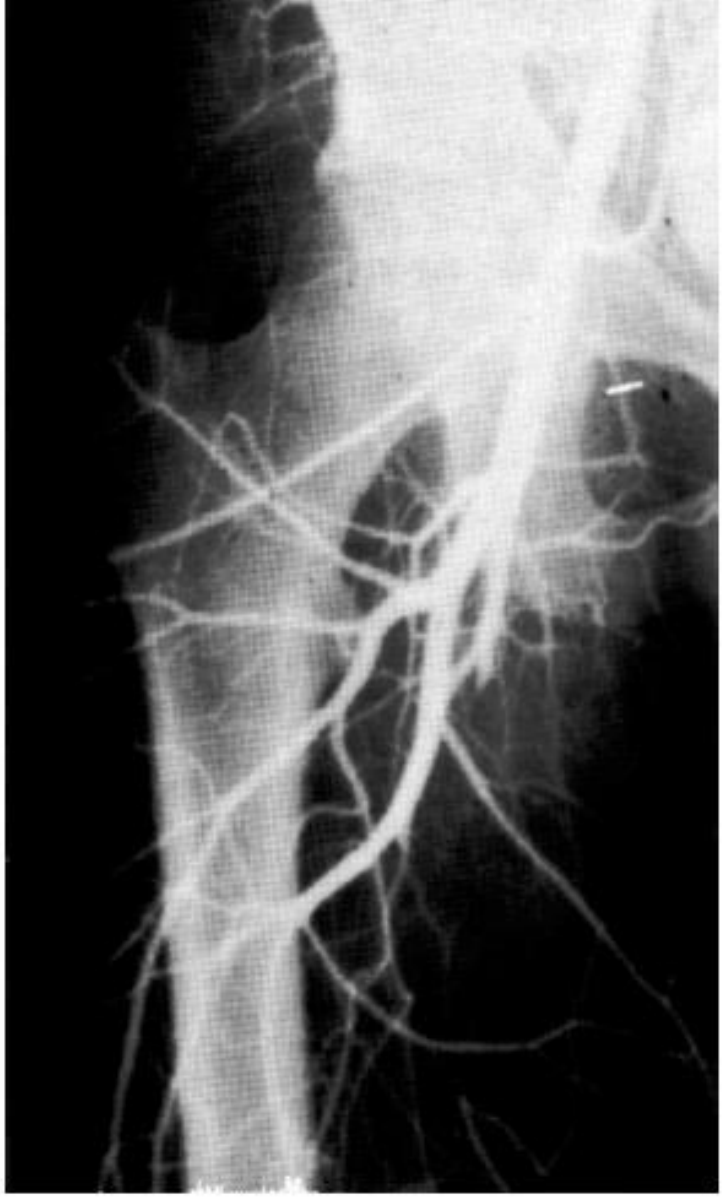


Figure 15. A knowledge of anatomy is mandatory to prevent complications as noted above. It was documented in Vietnam that a *large* profunda femoris artery was ligated. This angiogram later confirmed the clinical suspicion that the superficial femoral was the artery that was ligated. (Vietnam Vascular Registry No. 1129, NMR.) (*From* Rich NM, Spencer FC: Vascular Trauma. Philadelphia, WB Saunders, 1978, p 120; with permission.)

Figure 3. Multiple small pellets and significant swelling of the left lower extremity are visualized in this patient who sustained a shotgun wound to the left thigh 10 years before presenting to the hospital complaining of increase in size of the extremity, ulcerations in the distal extremity, and the presence of a thrill.

Figure 4. Arteriogram shows a large superficial femoral arteriovenous fistula with massive dilation of the left femoral and iliac vein. The fistula was repaired with a resection and interposition graft of the superficial femoral artery and repair of the vein from within the fistula. The patient had an uneventful recovery with healing of the ulcers and decrease in size of the extremity.

Delayed

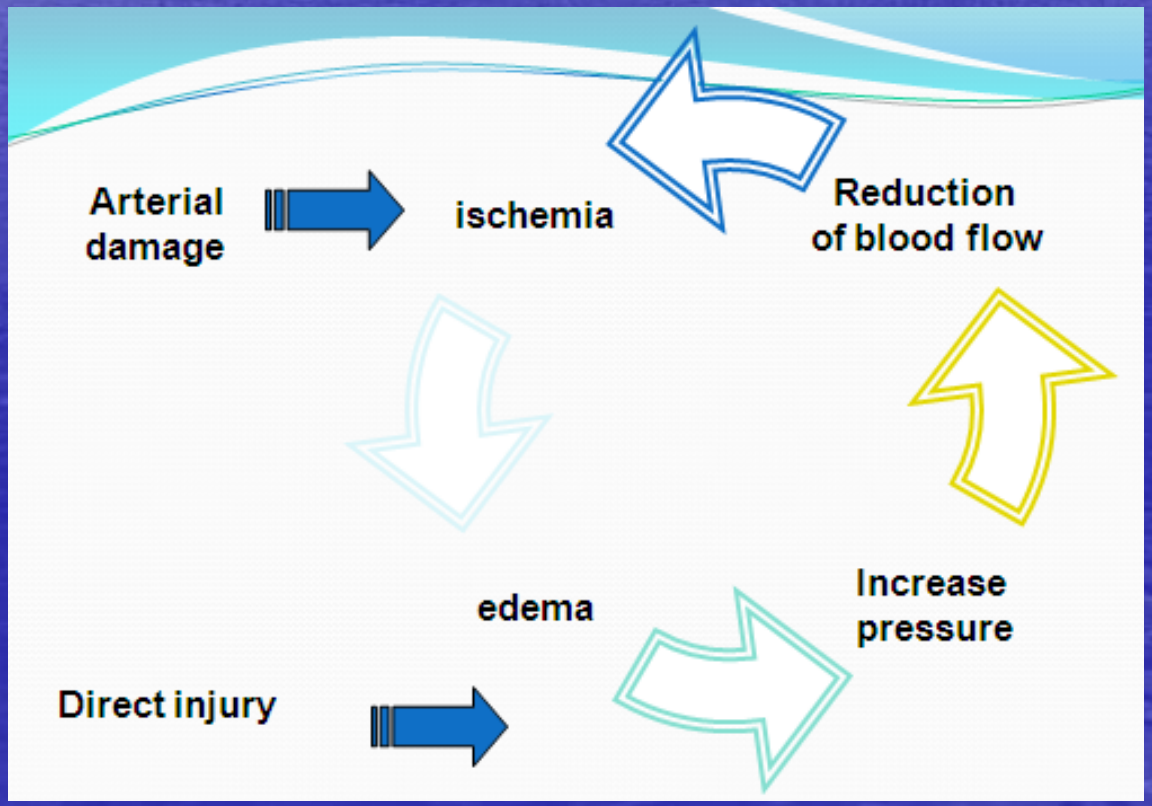
1. Chronic pain Drapanas et al (1970)7 found that chronic pain was a complaint in10.2%
2. Decreased function
3. Ischemic changes
4. Systemic complications
5. Arteriovenous fistulas and false aneurysms
6. Arteriosclerotic changes thickening and stiffening of the arterial walls,
7. Aneurysmal graft changes

Compartment Syndrome

bad complication

- occurs when muscle swells within osteofacial compartment pressure exceed capillary pressure they end up with ischemia

serious and potentially life-threatening condition that occurs when there is increased pressure within a closed anatomical space (compartment), leading to impaired blood flow, tissue ischemia, and potentially permanent damage to muscles, nerves, and other tissues. This condition most commonly affects the limbs, especially the lower leg and forearm, but it can also occur in other parts of the body.



symptoms of compartment syndrome :

- Pain, aggravated during stretching of the muscle group involved.
- Pressure.
- Paresthesia.
- Paralysis, late manifestation
- Pulselessness very late stages
- Pallor

TREATMENT

Fasciotomy--> is the definitive treatment for ACS in the great majority of cases

- Adequate skin incision and an adequate fascial incision
- Pharmacologic Interventions
- Mannitol

Fasciotomy

Fasciotomy to fully decompress all involved compartments is the definitive treatment for ACS in the great majority of cases

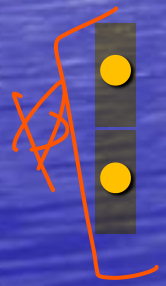

medial compartment


lateral compartement

INDICATIONS FOR FASCIOTOMY

in compartment syndome
open skin and subcutaneous tissue and fascia

- Prolonged hypotension
- Swelling of the extremity
- Extensive soft tissue damage
- Combined venous and arterial injury
- Combined bony plus arterial or venous injury or both
- Delay between injury and definitive repair
- Compartmental pressure 35 mm Hg



FEMORAL

Femoral

- 70% of all arterial
- More than 90% penetrating Stap wound
- most resulting from GSWs.
- Injuries to the femoral artery are not commonly associated with fractures of the femoral shaft

OPERATIVE MANAGEMENT

- proximal injuries it is wise to initially expose the distal common iliac vessels through a separate incision control before entering the femoral triangle.
- The length of the sterile field includes the entire abdomen to the toes in both lower
- bleeding can be controlled by direct pressure from the source of bleeding
- Blind clamping is strongly discouraged

avoid

- In combined arterial and venous injuries, the vein is repaired first potency rate better and less complications
- Published data clearly show that venous repairs improve the likelihood of successful arterial repairs and minimize potential long-term complications

Associated Venous Injuries

The only proven benefit of venous ligation is reduced operating time

1) improved patency of associated arterial repairs because preserved venous patency maintains normal distal vascular bed resistance, thus optimizing blood flow and reducing stagnation; and

(2) reduced incidence of chronic venous insufficiency and associated postphlebitic syndrome

- autogenous saphenous vein graft is the conduit of choice
- polytetrafluoroethylene can be used with good results if saphenous vein is not good or have problem
- If vein ligation is performed, early fasciotomy is indicated

POPLITIAL

Popliteal

Most cases present with ‘‘hard signs of vascular injury,
•clinical picture DIAGNOSIS

- 12% of all arterial injuries
- the civilian sector has provided the bulk of experience with these injuries,
- blunt mechanisms account for 20% to 75% of all cases.

trauma caused by non-penetrating forces, which may involve a direct blow, impact, or compression to the body (damage without breaking the skin.)

in femoral --> penetrating trauma (gunshot)

DIAGNOSIS

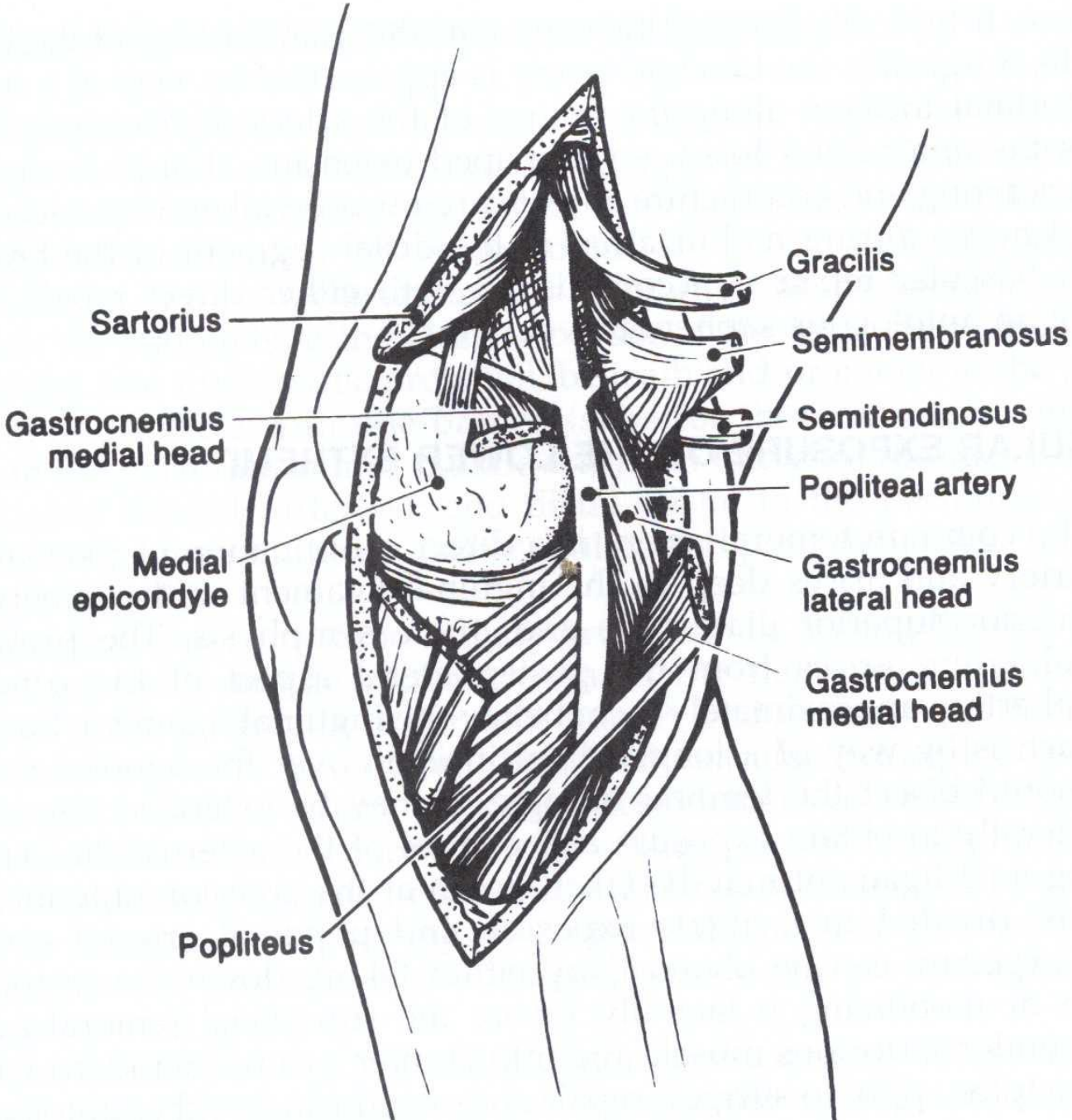
- Most cases present with “hard” signs of vascular injury,
- clinical picture DIAGNOSIS

TREATMENT

end to end anastomosis

network of collateral blood vessels around the knee joint, which are important in maintaining blood flow to the lower leg in cases where the main arterial supply (usually from the femoral artery) is compromised or occluded

- **Surgical Repair**
- Medial longitudinal incision placed 1 cm posterior to the distal femur and proximal tibia
- End-to-end anastomosis
- Division of geniculate collaterals to achieve mobility should be avoided
- Prosthetic grafts across the knee joint generally have lower patency rates than does vein and are best avoided
- popliteal vein injuries should be repaired.


Gracilis
Sartorius
Semimembranosus
Gastrocnemius
medial head
Semitendinosus
Popliteal artery
Medial
epicondyle
Gastrocnemius
lateral head
Gastrocnemius
medial head
Popliteus


a
b
c

Shank vessels

shank vessels (the portion of the leg between the knee and the ankle)

- management is still controversial.
- uncertainty of the number of patent arteries needed for limb viability.
- Some suggested that ligation of shank vessels is safe as long as one patent vessel remains.
- Others argue that there is a 14% amputation rate after ligation of one of the tibial vessels,
- 65% after ligation of two vessels,
- any injury to the shank vessels, with the exception of isolated peroneal injury, should be repaired

DIAGNOSIS

- “hard andsoft signs”
- (ABI).
- Color-flow duplex
- Angiography

Associated Injuries

- thorough neurologic examination
- 10% and 58%.
- Associated bony injuries are reported to occur in approximately35% of cases

posterior tibial artery or peroneal artery

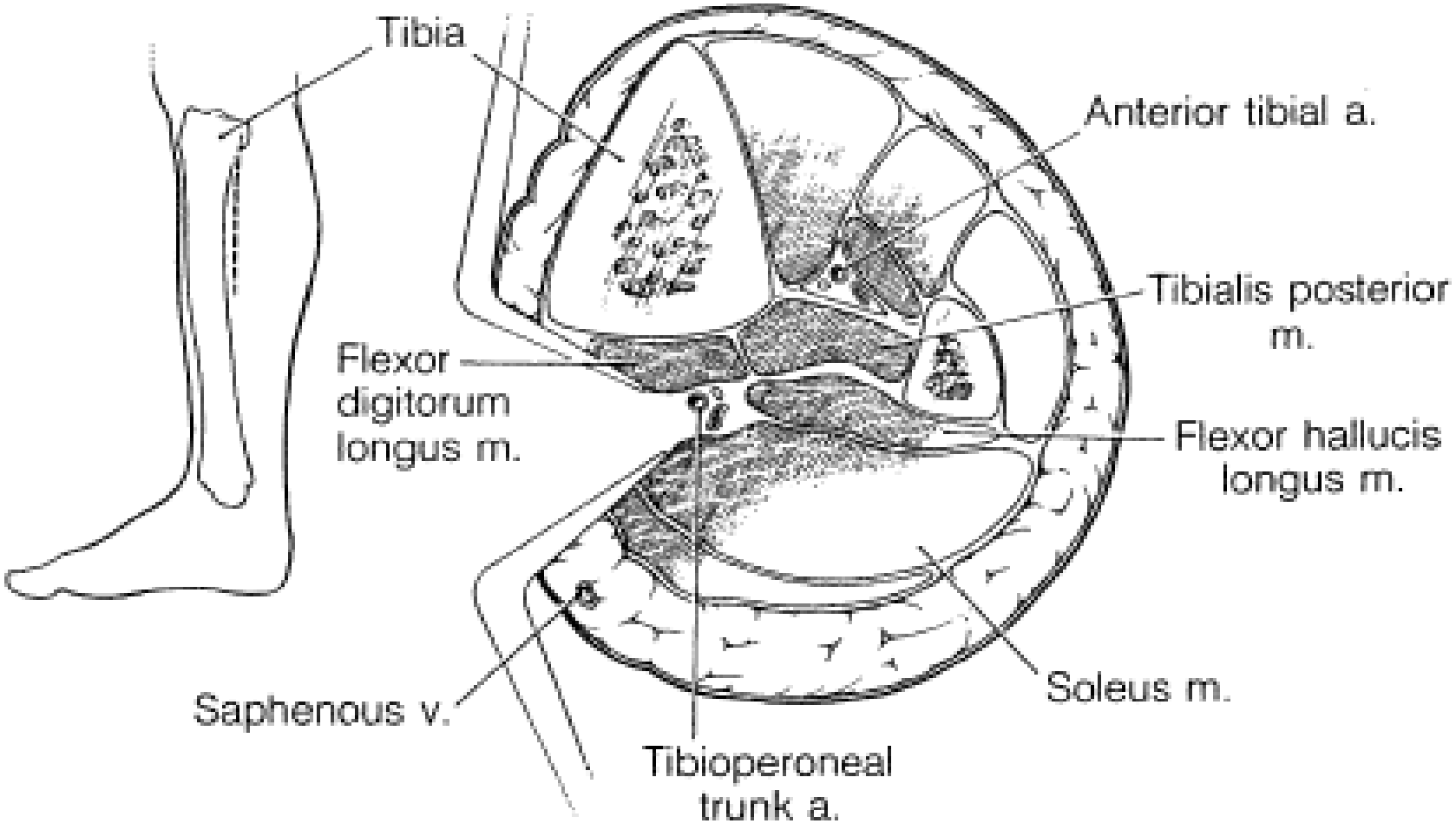


Figure 1. Operative exposure: Tibioperoneal trunk.

Anterior Tibial Artery

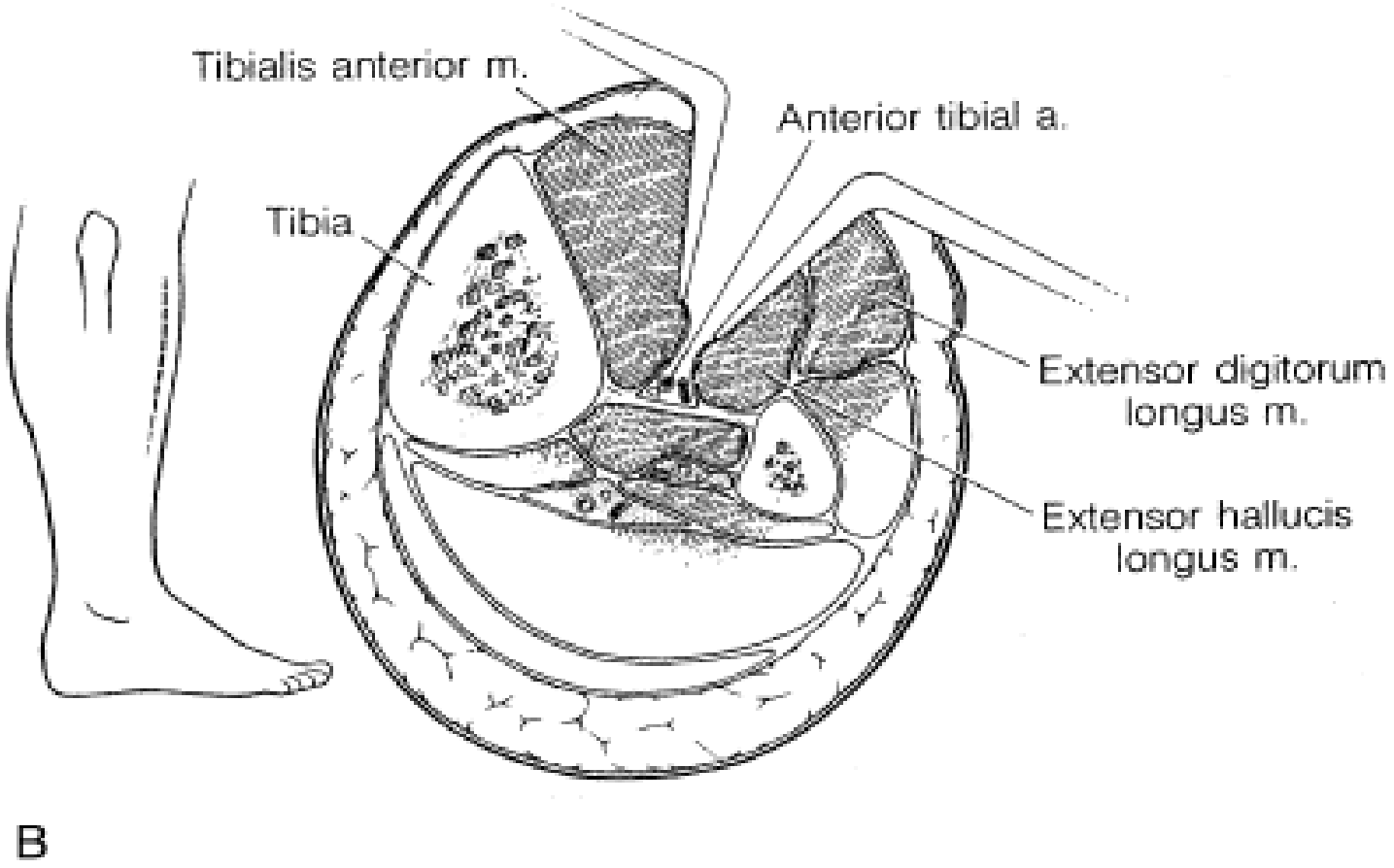


Figure 3. Operative exposures: (Lateral) Shank arteries mid-leg *(A)*, anterior tibial arter *(B)*.