VASCULAR INJURIES
Vascular injuries have become common in urban practice due to increased violence, rapid transport & early diagnosis & successful operative management of injured patients.

**Pathophysiology:** pathologic consequences may result from hemorrhage or ischemia distal to the injury that can result in limb or organ loss depending on *degree of collateral circulation, *sensitivity of the tissue to ischemia and the delay involved before repairing the injury [brain ischemia$>4\text{min}$, nerve & muscle ischemia$>4\text{h}$ will result in permanent injury].

* Mechanism of acute ischemia include; anoxic phase & reperfusion phase [production of toxic metabolites will cause severe endothelial injury]

* In significant muscle ischemia, products of necrosed muscle [myoglobin, potassium] results in acidosis, hyperkalemia & renal failure & may be fatal

* Pathologic types of arterial injury include; incomplete tear, complete tear, contusion thrombosis, intimal flap occlusion, & arteriovenous fistula, delayed effects include pseudoaneurysm, thrombosis & distal embolism.

* Blunt trauma, may be caused by deceleration, falls ..etc & can cause intimal fracture with dissection, pseudoaneurysm with delayed rupture.
DIAGNOSIS

- Although it is usually apparent on initial presentation, it also may be frequently occult. Careful history taking [bleeding, hypotension], nature & site of trauma. Mechanism & force of injury, history of altered mental status & neurological deficits. Plain chest films in thoracic trauma.

- Clinical examination; complete evaluation with special emphasis on pulse examination after proper resuscitation. Classic findings of 5p.

- Doppler examination ABI <0.9 or >20mmHg pressure difference arouses the suspicion, segmental pressure measurement, [presence of audible Doppler signals does not rule-out arterial injury].

- Duplex scanning valuable in rapid evaluation and good screening test for patients with equivocal clinical findings.

- Selective arteriography is fundamental in patients with suspected occult vascular trauma, indications; *moderate haemorrhage, *penetrating wound at the site of a major vessel, *diminished pulsations, *nerve injury with a proximal artery. Biplanar views & delayed films [to demonstrate venous filling in AV fistula] should be obtained. This can reduce the incidence of negative explorations from 60% to 35%.
MANAGEMENT

**NON OPERATIVE:** clinically insignificant lesions [focal spasm, intimal irregularity & small pseudoaneurysms] can be treated non operatively.

**OPERATIVE:**

- the initial step is control of bleeding not by blind clamping or by tourniquet (occludes collaterals causing severe ischemia), but by local pressure application.
- operative management should be orchestrated giving attention to life threatening conditions.
- Tetanus prophylaxis in penetrating wounds, systemic antibiotics & heparin to prevent propagated thrombosis (inappropriate in multiple injuries & brain injuries).
- In limb injuries both limbs should be prepared to be ready for vein harvest, in abdominal & neck injuries the chest should be prepared to access the thoracic aorta if necessary for proximal control.
- In cases of vascular trauma with skeletal injuries, vascular repair should be done first and the repair should be re-examined after conclusion of bone fixation.
Extensive limb injuries including soft tissues bones nerves & vessels (mangled extremity) require a special scoring system. To assess the feasibility & success of repair rather than amputation.

**COMPONENTS OF THE MANGLED EXTREMITY SEVERITY SCORE**

<table>
<thead>
<tr>
<th>SKELETAL OR SOFT TISSUE INJURY</th>
<th>Points</th>
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<tbody>
<tr>
<td><strong>Low energy</strong>: stabs, simple fractures, low-velocity gunshot wounds</td>
<td>1</td>
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<tr>
<td><strong>Medium energy</strong>: open or multiple fractures, dislocations</td>
<td>2</td>
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<tr>
<td><strong>High energy</strong>: close-range shotgun wounds, high-velocity gunshot wounds, crush injuries</td>
<td>3</td>
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<tr>
<td><strong>Very high energy</strong>: high-energy plus gross contamination, major soft tissues</td>
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**LIMB ISCHEMIA**

| Precordice reduced or absent, perfusion normal | 1 |
| Pulseless, with paresthesia, delayed capillary refill | 2 |
| Cool, paralyzed, insensate, numb | 3 |

All ischemia scores are doubled if ischemia time >6 h)

**SHOCK**

| Systolic blood pressure always >90 mmHg | 0 |
| Transient hypotension | 1 |
| Persistent hypotension | 2 |

**AGE**

| <30 y | 0 |
| 30–50 y | 1 |
| >50 y | 2 |

A score > 7 predicts 100% amputation
- Proper technique using monofilament sutures appropriate size needles, magnification loops & vascular instruments.
- Intra-operative completion angiography is mandatory to assess adequacy of the repair. And visualize runoff.
- The repair of concomitant venous injury is controversial & should not be attempted in a hemodynamically unstable patient.
- Compartment syndrome is a devastating complication occurs in the calf if:
  1. ischemia > 6h,
  2. crush injury,
  3. preoperative calf swelling,
  4. combined arterial & venous injuries,
  5. extensive venous ligature,
  6. post-operative disproportionate calf pain,
  7. elevated intra-compartment pressure.
Is treated by 4 compartment fasciotomy
- Coverage with viable muscle or fascia is essential
- The use of postop. Heparin increases the incidence of wound hematoma, only used with venous compromise
COMPLICATIONS

- Early thrombosis, needs prompt recognition & re-operation
- Significant swelling, suggests venous thrombosis, needs duplex scan and treated by heparin & elevation
- Infection, is a devastating complication resulting in secondary hemorrhage. Treated by ligature & extra-anatomic bypass.
- Late complications include; stenosis, aneurysmal changes, post-phlebitic limb syndrome.

Management of specific vascular injuries

Injury to thoracic great vessels;

- Occur due to both blunt & penetrating injuries life-threatening due to bleeding or associated severe injuries. Penetrating injuries are usually associated with hemothorax needing emergency thoracotomy
- Angiography is indicated if; *peripheral micro-emboli*proximity of injury to a great vessel & *mediastinal hematoma on plain X-ray
- Penetrating injuries of ascending aorta innominate A. & rt. Subclavian A. are approached through a median sternotomy.
- Venous ligation is well tolerated.
- Almost all survivable great vessel injury result in pseudo-aneurysm. With a mortality of 50% in the 1st 24 hours.
- Surgical management consists of suture repair or synthetic graft interposition.
- Cardiopulmonary bypass should be available in case of the need of proximal aortic occlusion.
- Paraplegia is an important complication [8%] because of ischemia due to occlusion of ant. Spinal artery.
**Abdominal vascular injuries**

- Major abdominal vascular injuries are diagnosed at laparotomy except for the renal artery which can be diagnosed preoperatively on finding a nonvisualized kidney on IVU & confirming by angiography.

- If the patient is severely shocked proximal control could be achieved by supraceliac control through a thoracotomy prior to resuscitation & laparotomy. Retroperitoneal hematomas are not opened before achieving proximal & distal control.

- Bowel injury should be closed to avoid contamination of the field.

- Identification of the source of bleeding may be difficult, exposure of the aorta below the diaphragm is sometimes needed to gain proximal control.

- Exposure of the infrarenal aorta is done by mobilizing the small intestine to the right side.

- Superior, inferior mesenteric, left renal & iliac arteries, are exposed by reflecting the left colon and spleen.

- The IVC, right Renal & iliac arteries are exposed by...
A Kocher maneuver combined with mobilization of the right colon

- Repair is done by primary suture, patch Angioplasty or saphenous interposition. Synthetic Grafts should be avoided in the presence of bowel Injuries. Post operative angiography is difficult & Intra operative doppler or duplex are advised.

- Injuries to the venacava & portal vein are difficult to repair because of difficult proximal & distal control & high risk of thrombosis. Their ligature is only done to save life as supra renal venacaval ligature is fatal & portal vein ligature will deprive the liver of 80% of its blood supply. Mesenteric veins can be ligated without significant complications.

**Extremity vascular trauma:**

- Penetrating trauma is more common than blunt in extremity vascular injuries. Common arteries affected are the brachial & femoral. Blunt trauma occur with major fracture dislocations[ supracondylar fracture & knee dislocation. Associated nerve injury occur in 60%.
In upper extremity; due to extensive collaterals & small muscle mass, ischemia is milder than the leg, but should be treated promptly. Isolated radial or ulnar artery injury can be treated with simple ligature. Fasciotomy is rarely indicated in cases of extensive & delayed injuries.

In the lower extremity; lack of good collateral circulation & large muscle mass increases the risk of limb loss. Femoral artery injuries can be repaired directly while popliteal artery injuries require interposition grafting. Isolated tibial vessel injury is treated with simple ligature, liberal fasciotomy is frequently needed to avoid compartment syndrome.

Completion arteriography & close observation is needed.

Venous repair is controversial.

Primary amputation is done in severe injuries.
THANK YOU