



Abdominal Injuries

Emergency Surgery



Dr. Badri Kobalava
badri.kobalava@ciu.edu.ge



<https://sites.google.com/view/dr-badri-kobalava-ciu>

Abdominal Trauma: Evaluation and Decision Making

Abdominal Trauma: Evaluation and Decision Making

- Abdominal injuries
 - blunt
 - compression causing a crush injury
 - an abrupt shearing force causing tears
 - a sudden rise in intra-abdominal pressures causing a rupture of abdominal viscera.
 - penetrating
 - Penetrating mechanism injuries result from lacerations or blast effect.
- Motor vehicle crashes account for 75% of blunt abdominal injuries.
-
- The abdomen includes three basic regions:
 - the peritoneal cavity with its intrathoracic component,
 - the retroperitoneum
 - the pelvic portion
- blunt and penetrating injuries to the lower chest may involve abdominal organs.
-

Abdominal Trauma: Evaluation and Decision Making

- The evaluation of the patient with abdominal trauma
 - focused history
 - physical examination
 - laboratory investigations
 - abdominal sonography
- advanced trauma life support (ATLSR)
course hold in the evaluation of patients with abdominal trauma.
- The primary goals of the abdominal evaluation
 - to identify whether or not an intraabdominal injury is present
 - to determine if the injury requires operative repair.
-

Blunt abdominal trauma

Blunt abdominal trauma

- History

- character and duration of any abdominal complaints
- Worsening abdominal pain or tenderness may signal progression
- peritoneal irritation (from succus, bile or blood)
- unable to provide a history secondary to hypotension/haemorrhage, head injury, intoxication and endotracheal intubation. Therefore, it is important to obtain information from prehospital personnel regarding the time of injury, mechanism and use of restraint devices.

- Physical examination

- inspection of the front and back of the abdomen, the perineum and the lower chest.

- Lab

- CPC
- ABO & Rh group and cross-match
- hepatic transaminases
- urinalysis
- haemoglobin-haematocrit and amylase-lipase (every 6-8 hr if are managed nonoperatively.)

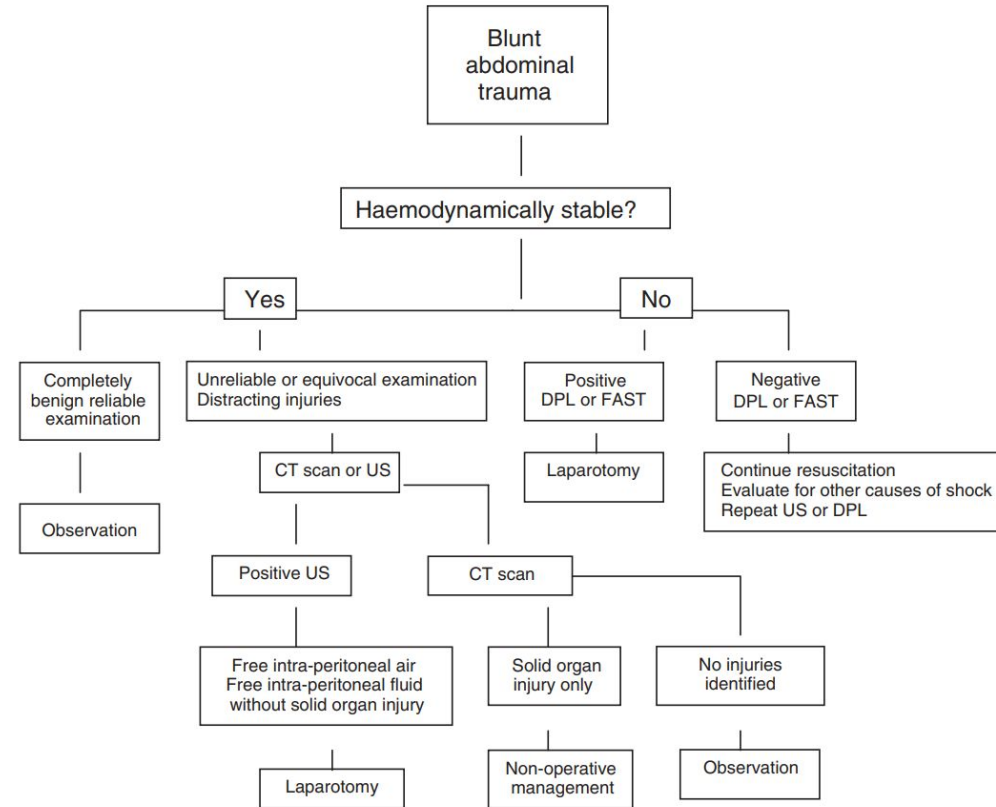
- Chest radiograph (CXR)

- Free air
- with a nasogastric tube in place, may help to identify an elevated or disrupted hemidiaphragm.
- Pelvic plain films
- may help in identifying a fracture

-

Computed tomography

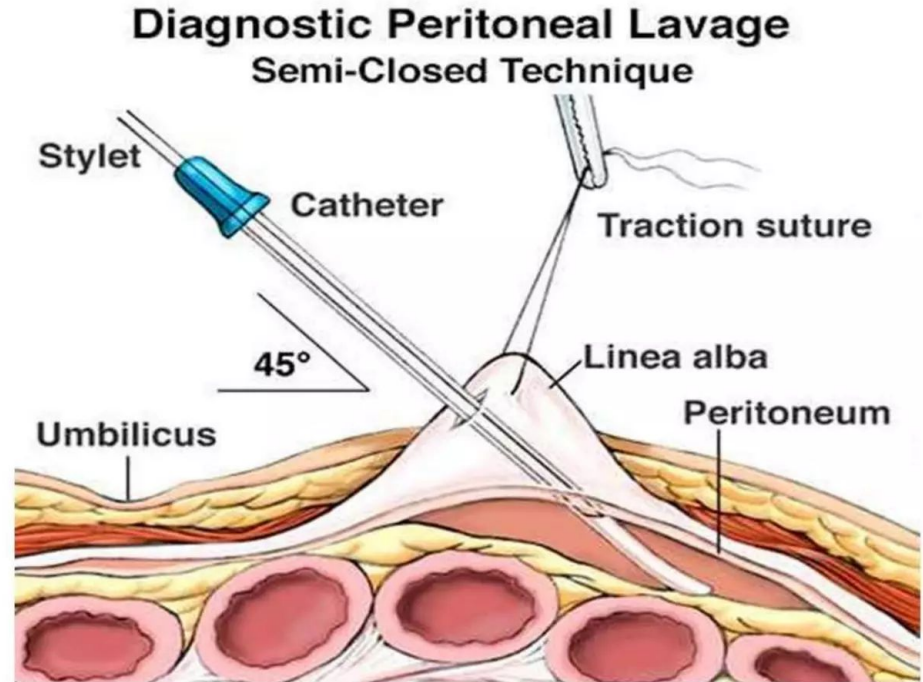
- In the hemodynamically stable patient who sustains blunt abdominal trauma⇒ preferred method of evaluation
 - **Abdominal CT is very accurate in assessment of the liver, kidney and spleen.**
 - **CT has limited value in identifying intra abdominal injury to hollow viscus and the diaphragm.**
 - presence of active extravasation
 - free intraperitoneal fluid or air.
- thickened bowel wall, asymmetric bowel wall enhancement, interloop fluid and free fluid not explained by other injuries.
- Women of childbearing age may have a small amount of physiologic free fluid in their pelvis (≈50 cc).



Diagnostic peritoneal lavage



- The open technique
 - a small (2–5 cm) incision below the umbilicus
- The percutaneous technique (Seldinger fashion) - a small (0.5 cm) incision below the umbilicus.
- If aspiration of the DPL catheter does not reveal gross blood, 1 L of warm saline is infused. The fluid is then siphoned back and is examined macroscopically, microscopically and biochemically.
- **DPL is that it is very sensitive (>95%) for identifying intraperitoneal haemorrhage.**
- **DPL currently has limited application.**
- Indications for DPL in blunt trauma
 - CT is not available
 - suspected intra-abdominal injury and an equivocal examination.



A

IV fluid bag

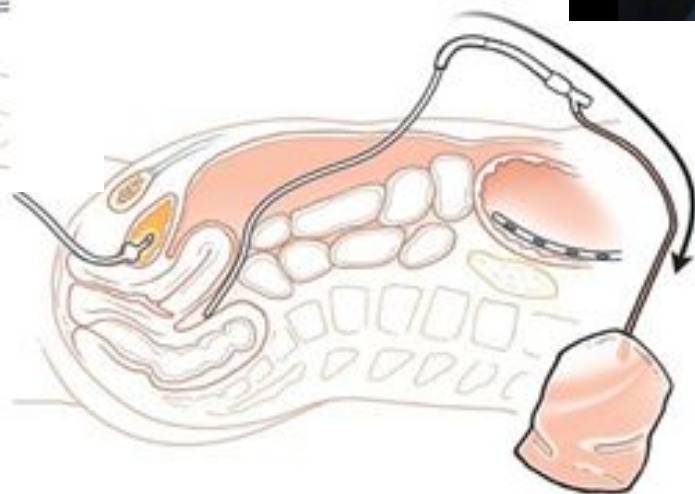
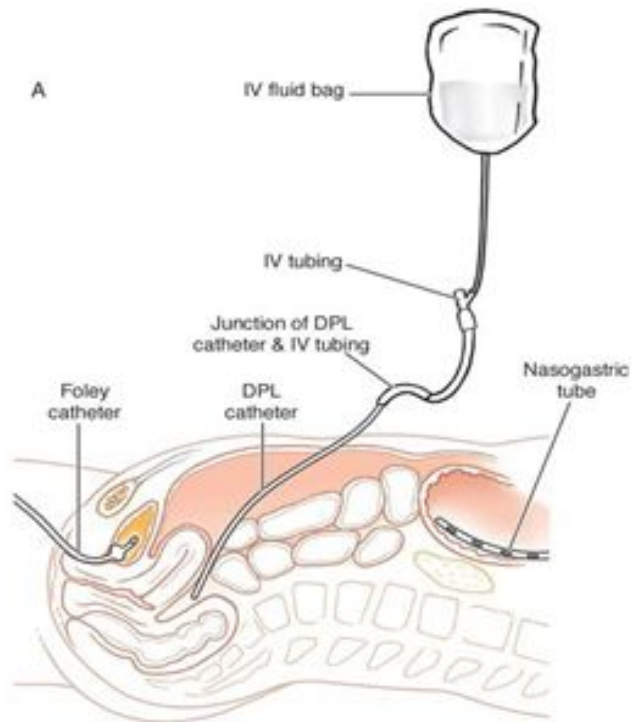
IV tubing

Junction of DPL catheter & IV tubing

Foley catheter

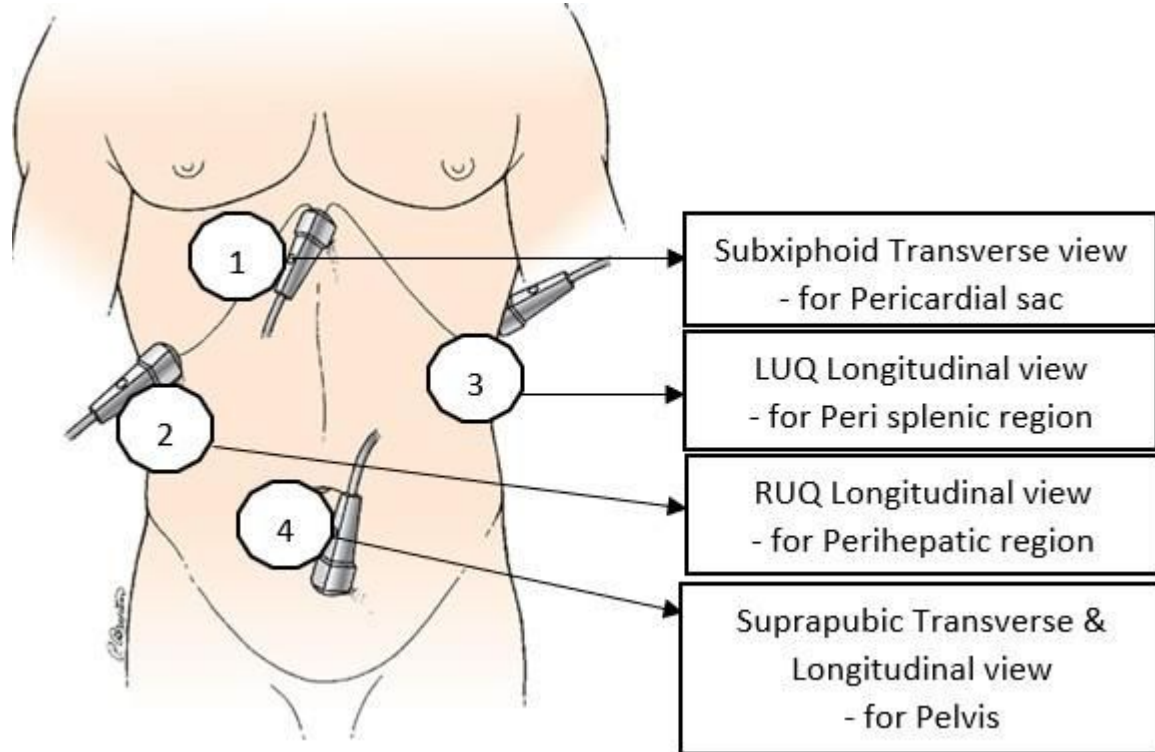
DPL catheter

Nasogastric tube



Focused Assessment With Sonography for Trauma

Patients who remain hypotensive or labile in the presence of (+) FAST or DPL findings should undergo immediate laparotomy.





კვლევები

- **Rigid sigmoidoscopy** - Extraperitoneal rectal injuries (performed in the emergency department or operating room).
- **Diagnostic laparoscopy**
 - **Has a limited role in the evaluation of the blunt abdominal trauma patient.**
 - e technical difficulty in 'running' the bowel
 - inability to diagnose retroperitoneal injuries
 - difficulty of adequately exposing deep lying organs such as the spleen.
-
- Evaluation of the urogenital tract
 - can have a delayed presentation
 - Signs:
 - Gross blood at the urethral meatus
 - gross haematuria
 - difficulty placing a urinary catheter
 - Microscopic haematuria
 - **Injury to the bladder** is particularly common in patients with severe pelvic fractures.
 - Gross haematuria is an indication for a **cystogram** - Plain radiographs after the injection of contrast through a urinary catheter and after evacuation of the contrast should be obtained.
 - Free spillage of contrast in the abdomen ⇨

Penetrating abdominal trauma

Penetrating abdominal trauma

- History
 - Attempt should be made to **identify the weapon used**.
- A brief medical history
 - Medications,
 - Drug allergies
 - Current medications
 - A history of prior abdominal surgery
- Physical examination
 - **Determining trajectory** is the single most important function of a physical examination or radiograph prior to laparotomy.
 - Quick and focused survey for all skin wounds.
 - Patients should be rolled to provide a thorough inspection with careful attention to the axilla and perineum.
 - All skin wounds should be marked s (e.g. **paperclips** taped over the wound)
- **Uncontrolled haemorrhage or evisceration from penetrating wounds warrants immediate operative exploration.**
- Laboratory evaluation
 - Will provide little guidance to the work-up and management
- Plain radiography
 - Chest and pelvic radiographs can be useful to identify **retained ballistic fragments and estimating a trajectory**
 - All wounds should be **marked with paperclips prior** to the radiographs.
 - Adequate films should include both diaphragms and the pelvis
- Computed tomography
 - High-resolution CT scans ⇨ accurately identify missile tracts and in some cases, identify patients who do not need operative exploration.

Penetrating abdominal trauma

- Local wound exploration
 - LWE can be performed **at the bedside with a local anaesthetic.**
 - An incision should be made and carried down to the level of the fascia to **determine whether or not there is a violation of the anterior fascia.**
 - If the anterior fascia has been violated, a **laparoscopy** may be performed to assess
 - for peritoneal violation,
 - When posterior fascial penetration cannot be ruled out **a full exploratory laparotomy** should be performed in the operating room.
 - **LWE can be difficult in obese or uncooperative patients.**
- Laparoscopy
 - Patients without peritoneal penetration
 - **laparoscopy may avoid an unnecessary laparotomy** and significantly shorten hospital length of stay
 - **Findings of peritoneal penetration at laparoscopy warrant full abdominal exploration**
 - Via laparoscopy - is highly operator-dependent and carries a higher risk of missed injuries.
 - Via conversion to a laparotomy

Penetrating abdominal trauma

- Rigid sigmoidoscopy
 - Penetrating injuries with trajectories **near the rectum** should be evaluated with rigid sigmoidoscopy
- Evaluation of the urogenital tract
 - Penetrating injury to the bladder
 - Conventional cystography
 - CT cystography
 - Laparotomy
 - Ureteral injuries
 - Both An Intravenous Pyelogram and CT have **high false-negative rates**.
 - Ureters should be inspected at the time of operation.
-
- Unnecessary laparotomies versus missed abdominal injuries
 - Unnecessary (non-therapeutic) laparotomies
 - The incidence - from 2 to 38%
 - Morbidities - 25%.
 - Non-operative management ⇨ delayed diagnosis - about 3.5%.

Trauma Laparotomy

Trauma Laparotomy

- The primary goals
 - Rapid control of **exsanguination**,
 - Control and minimisation of **bowel spillage**
 - Avoidance of the **lethal triad**:
 - Hypothermia,
 - Coagulopathy
 - Acidosis
- Initial trauma laparotomy **need to be performed rapidly** on patients with markedly disturbed preoperative and intraoperative physiology.
- It is crucial that you accompany your patient from resuscitation bay to the operating room.

Anaesthesia

- **Discuss with anaesthesia and OR team:** airway, access, injuries expected, potential need for blood products, whether or not the institution's massive transfusion protocol has been activated, and what preoperative antibiotics have been (or are to be) given.

Trauma Laparotomy

- Remember to request:
 - Blood-salvage systems
 - Fluid warmer/infuser,
 - Special suction devices that may be required. \
- Specify exactly how you would like the patient to be positioned, prepped and draped:
 - Always remind the team even if it is the same way every time.
 - Let them know of any procedures you might want to do prior to laparotomy (e.g. chest tubes and lines).
 - Ensure that the room is warm enough for this critically ill trauma patient who needs an emergent operation ($>27^{\circ}\text{C}$).
 - Let them know if you think you might do something out of sequence such as open the chest while someone else is opening the abdomen.
- You Carefully place headlight on yourself.
- **Make sure you are comfortable with everything in the room before leaving for the scrub sink.**
- For a 'standard' laparotomy:
 - The patient is placed supine
 - Arms out
 - Prepped from the neck to the knees and down to the table on both sides $\Rightarrow$ allow access to abdomen, both sides of the chest, mediastinum, zone 1 of the neck and bilateral groins.
 - Anaesthesia team can access both arms and enough of the neck $\Rightarrow$ vascular access and invasive monitoring.

Trauma Laparotomy

- If you suspect thoracoabdominal trauma the patient should be placed into a 'taxi-cab hailing' position.
 - Better access to the chest while not limiting abdominal exposure
 - Placing the patient up slightly on one side using a 'bump' or rolled blanket.



Trauma Laparotomy

- 'Getting into' the abdomen and identifying injuries '**same way, every time**' certainly applies here.
- **Unless the patient is crashing and needs an emergent aortic cross-clamp, patient should be prepped and draped in the sterile fashion.**
- The majority of self-retaining **retractors** will help to free-up your hands.
- Remember to **have access to bilateral chest cavities and groins, as well as sternal notch.**
- The incision should be large enough to accommodate rapid and adequate exposure for a thorough exploration.
- **The midline incision** is preferred in almost all cases.
 - While an incision spanning **xiphoid to pubis** is **the mantra of trauma laparotomy**, being judicious does not hurt.
 - Classic teaching ascribes to using the knife to cut through the skin, subcutaneous tissues and the fascia in **three broad knife strokes**.
 - It is important **not to cause injury** to either the patient
 - Once the preperitoneal fat is exposed, the abdominal cavity is entered with **a blunt finger push just above the umbilicus where the peritoneum is the thinnest**.
 - The peritoneal cavity is then fully opened with Mayo scissors.
 - Divide the ligamentum teres between clamps
 - Sharply divide the falciform ligament.

Trauma Laparotomy

- Initial packing
 - Packing starts in the quadrant with most suspicion for an injury and proceeds towards area of least suspicion for an injury.
 - Use of large handheld Richardson/Morris retractor
 - systematically pack off one quadrant at a time.
 - e self-retaining retractor, which has already been set up, can be simply dropped into the field.
 - In penetrating trauma, the trajectory of the injury can be ascertained and an injury pattern can be expected.
- - Knowing whether the injury is blunt or penetrating and expecting a pattern suggested by the trajectory or possible seat-belt sign or abdominal wall haematoma will help you manage your patient during the operation.
 - **Bleeding always needs to be addressed first.**
 - At this point, check out the zones of the retroperitoneum prior to removing packing. Should these demonstrate large or expanding haematomas, notify the anaesthetist of the increased risk for tremendous blood loss, make sure your institution's massive transfusion protocol is in place, and determine whether proximal and distal control are needed prior to proceeding with exploration.

Trauma Laparotomy

- Vascular injuries

- If packing did not help with ongoing haemorrhage chances are you are dealing with active intraperitoneal bleeding from the great vessels or from the porta/retrohepatic area.
- intraperitoneal haemorrhage of these largely retroperitoneal structures needs to be addressed first.
- contained retroperitoneal haematoma, judicious exposure and control depends on zone of the haematoma

- Temporary control

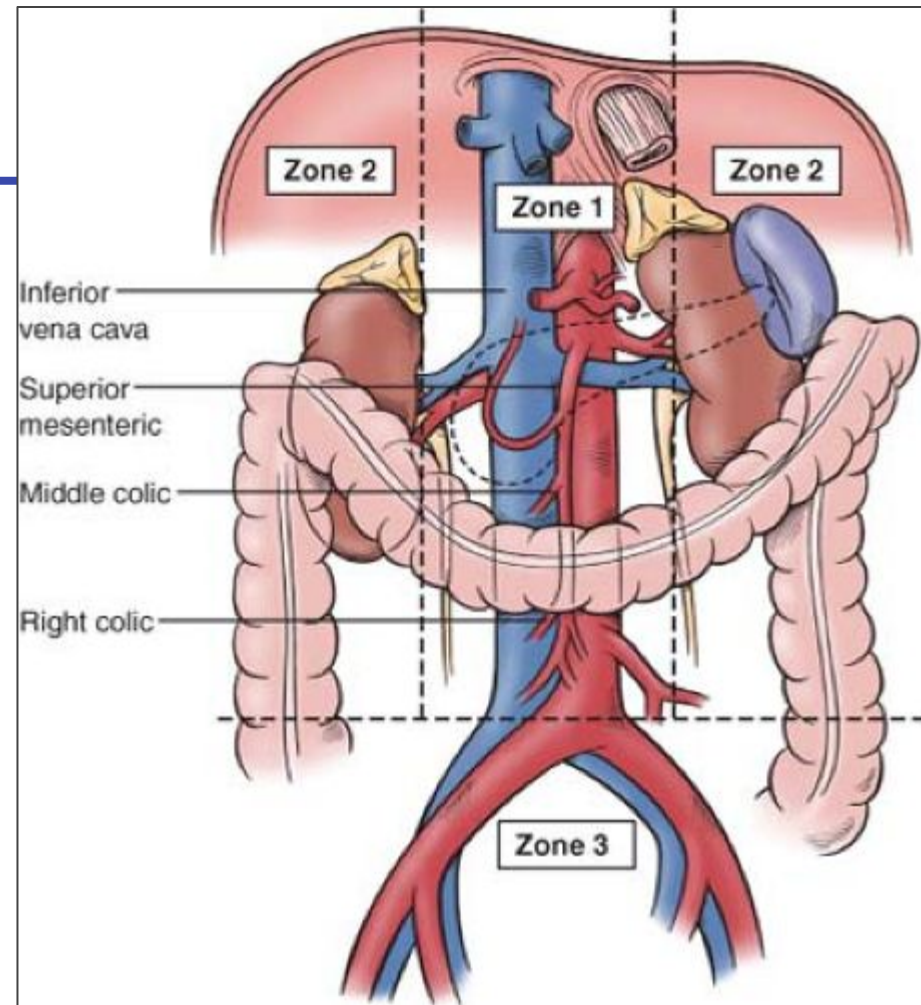
- obtain immediate and rapid vascular control
- The aorta can be accessed either through a left anterolateral thoracotomy or at the diaphragmatic hiatus with either an aortic occluder or a vascular clamp.
- Areas of injury



Table 26.3 Zone of vascular injury and plan of attack.

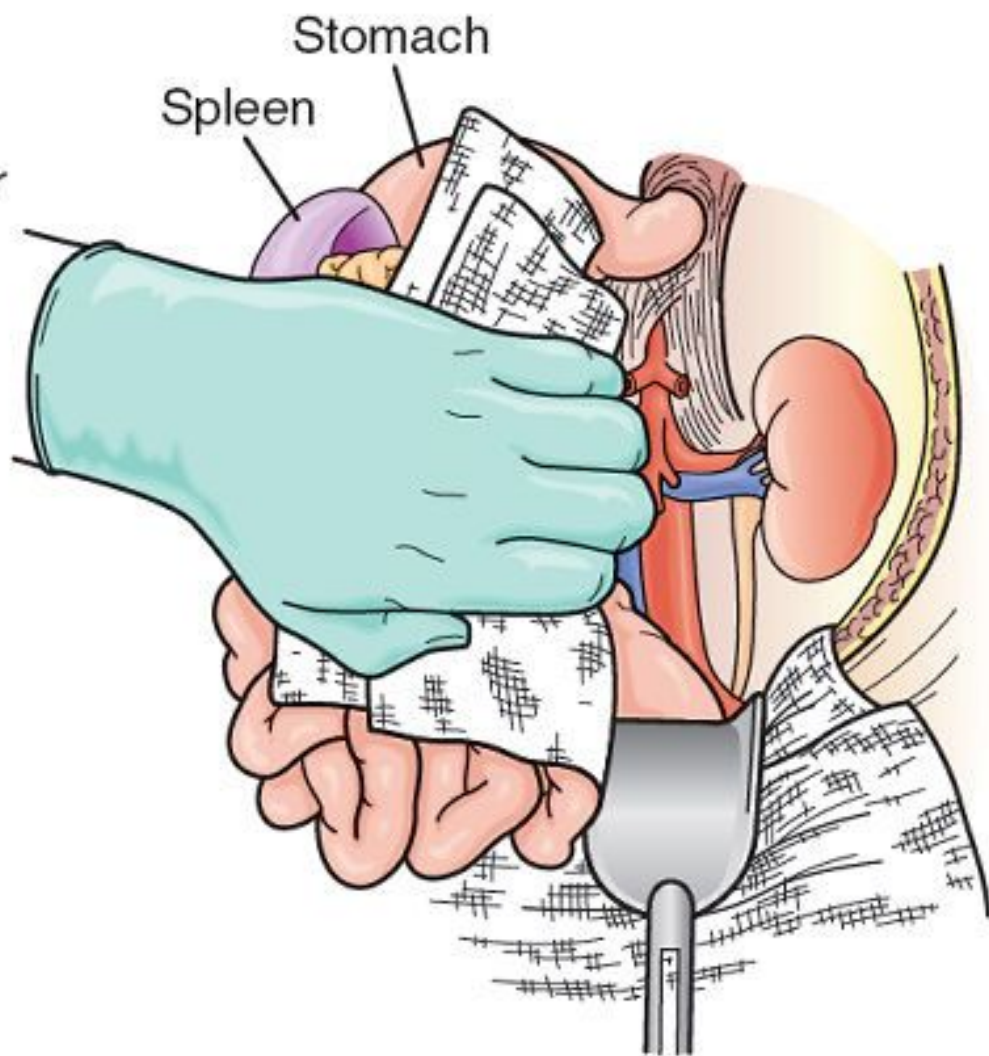
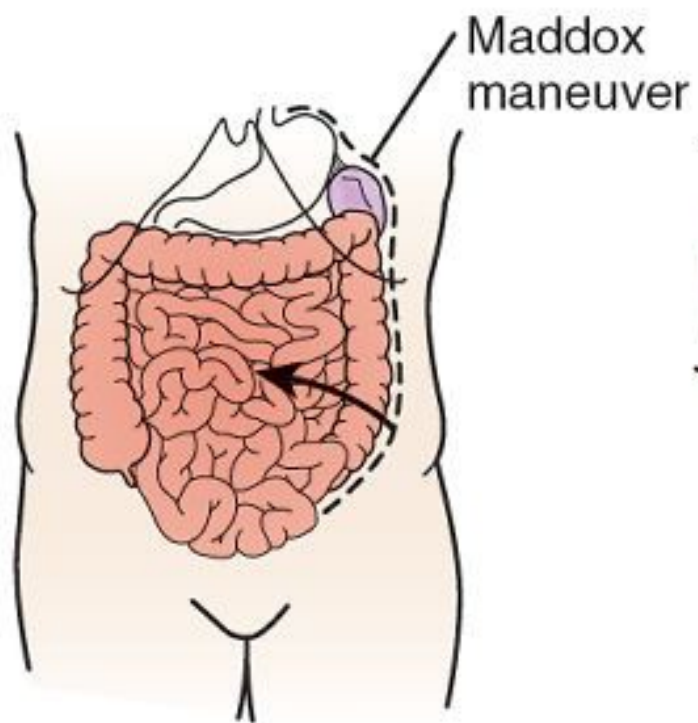
	Penetrating trauma	Blunt trauma
Zone 1	Explore	Explore
Zone 2	Explore	Explore only if active exsanguination
Zone 3	Explore	Explore only if active exsanguination
Porta	Explore	Explore
Retrohepatic	Do not explore unless active exsanguination	Do not explore unless active exsanguination

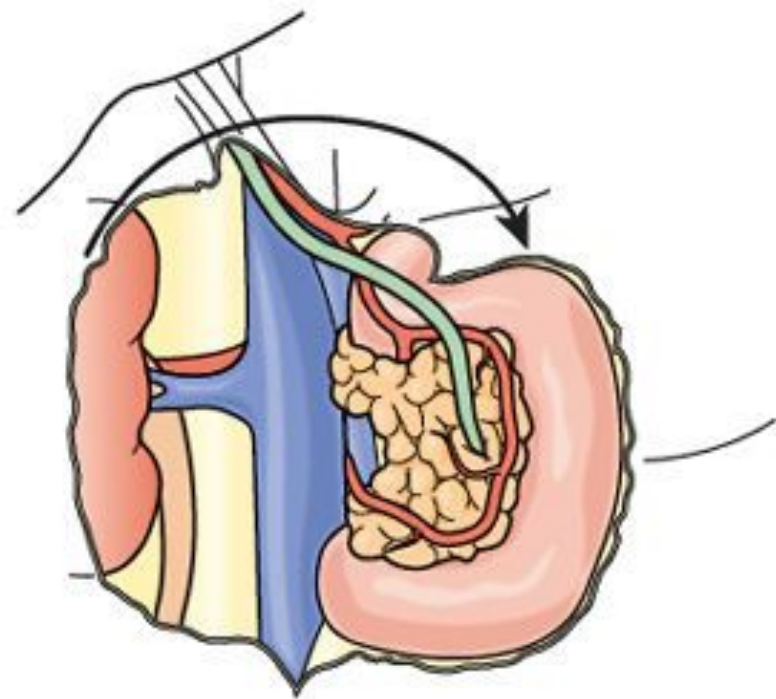
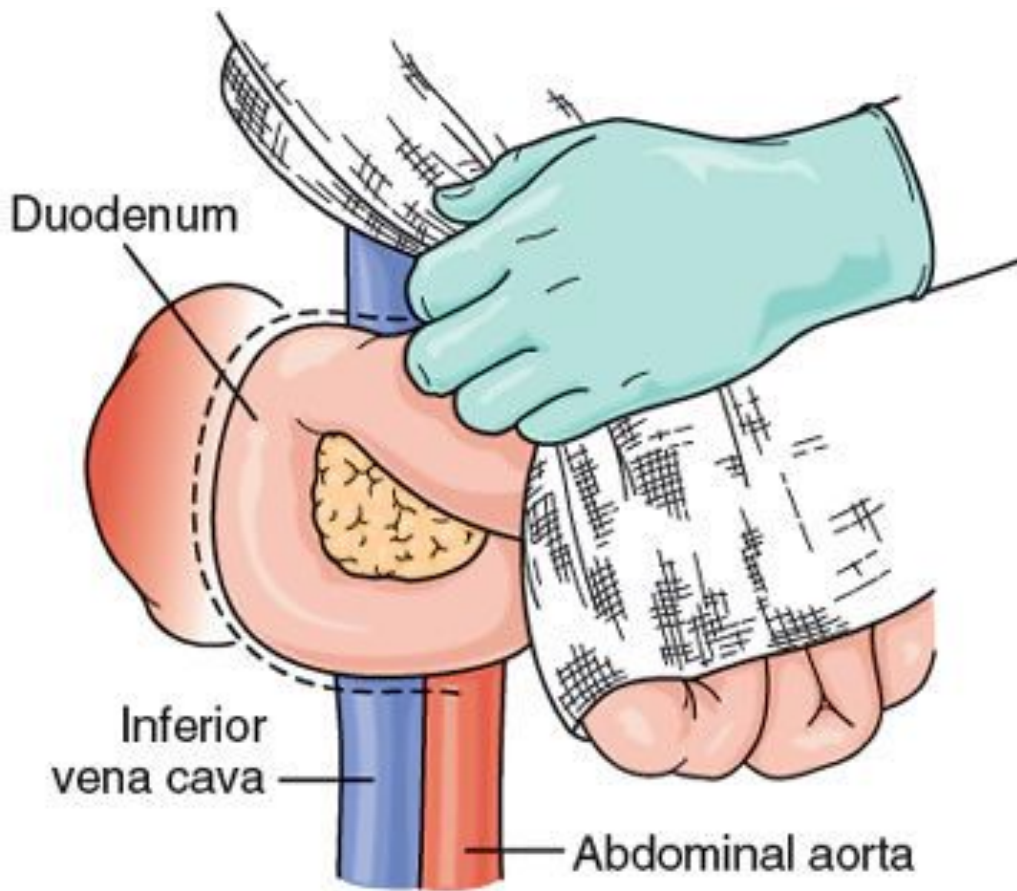
- Zone 1: aorta and inferior vena cava
 - Supramesocolic area
 - Inframesocolic area
- Zone 2: Renal vessels and the kidneys.
- Zone 3: Pelvis and iliac vessels.
- Porta/retrohepatic area: portal structures as well as the venous confluence of hepatic veins and the IVC.



Approach

- Supramesocolic (zone 1)
 - Aorta above the renal vessels) is best approached through **left medial visceral rotation = Mattox manoeuvre.**
 - The left colon is mobilised medially to expose the aorta.
 - If a very high aortic injury is suspected the kidney should be rotated medially as well, and the left crus of the diaphragm should be divided
- Inframesocolic (zone 1)
 - Left medial visceral rotation as well
 - An injury to the IVC be suspected, **a right medial visceral rotation = Cattell-Braasch maneuver.**
 - Alternative approaches to great vessels injury to the celiac or SMA aorta can be identified and isolated by **stapling and dividing the stomach.**
- Zone 2
 - Medial visceral rotation on the side of the injury
 - **Non-expanding haematoma blunt trauma ⇒ not need exploration**
 - **Non-expanding haematoma penetrating injury ⇒ Exploration.**





Wide Kocher maneuver

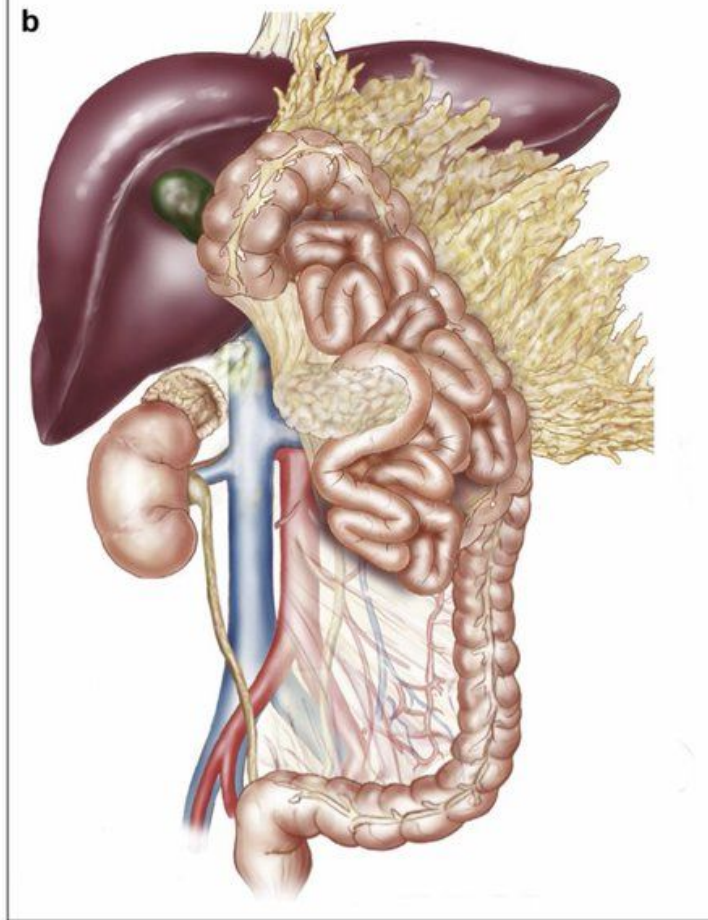
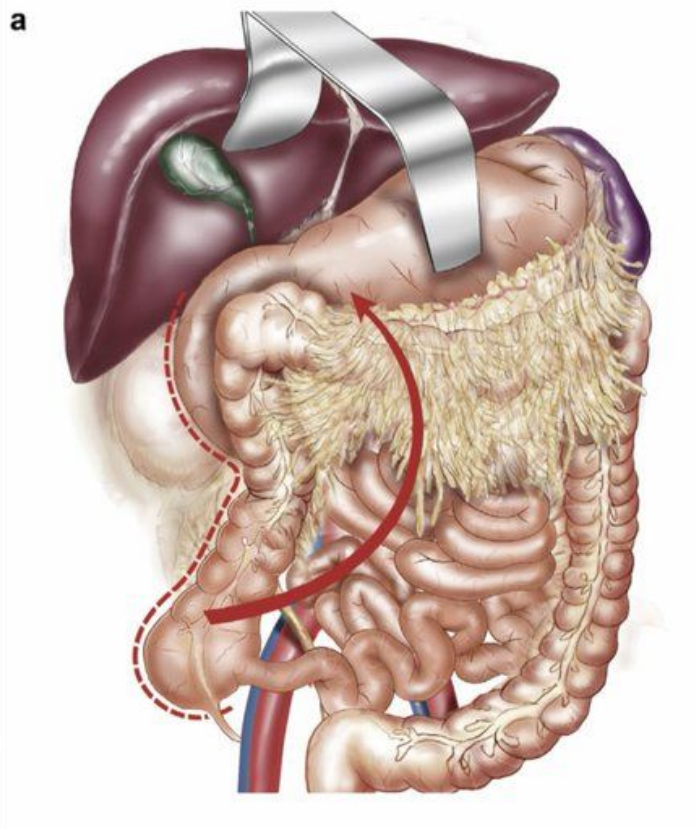
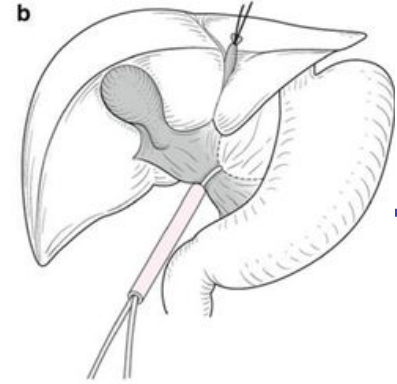
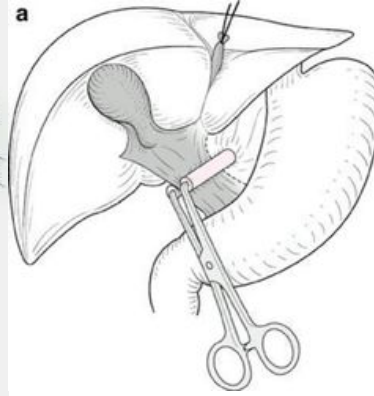
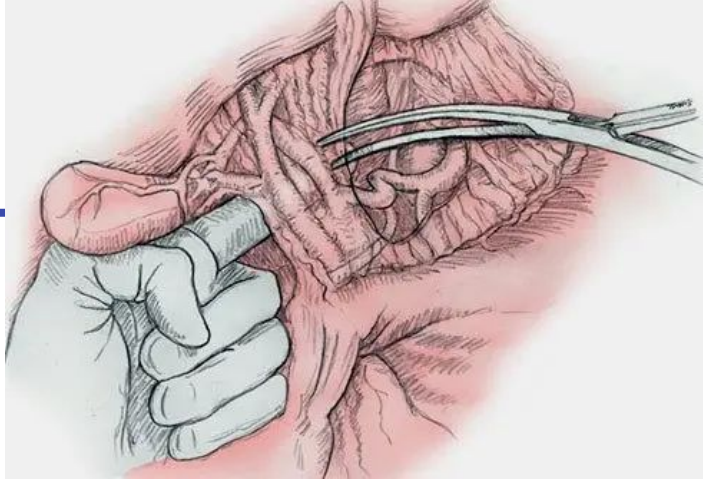
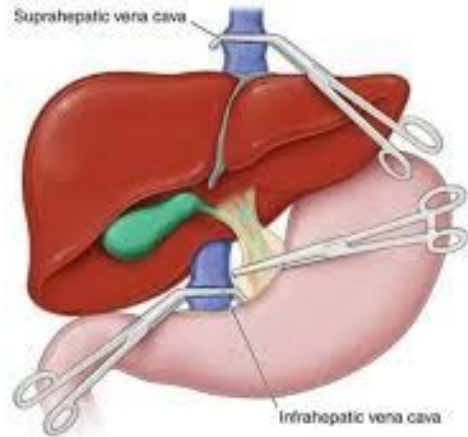


Figure 2. Cattell and Braasch's maneuver: right visceral rotation with extended duodenopancreatic mobilization followed by dissection of the mesenteric root.

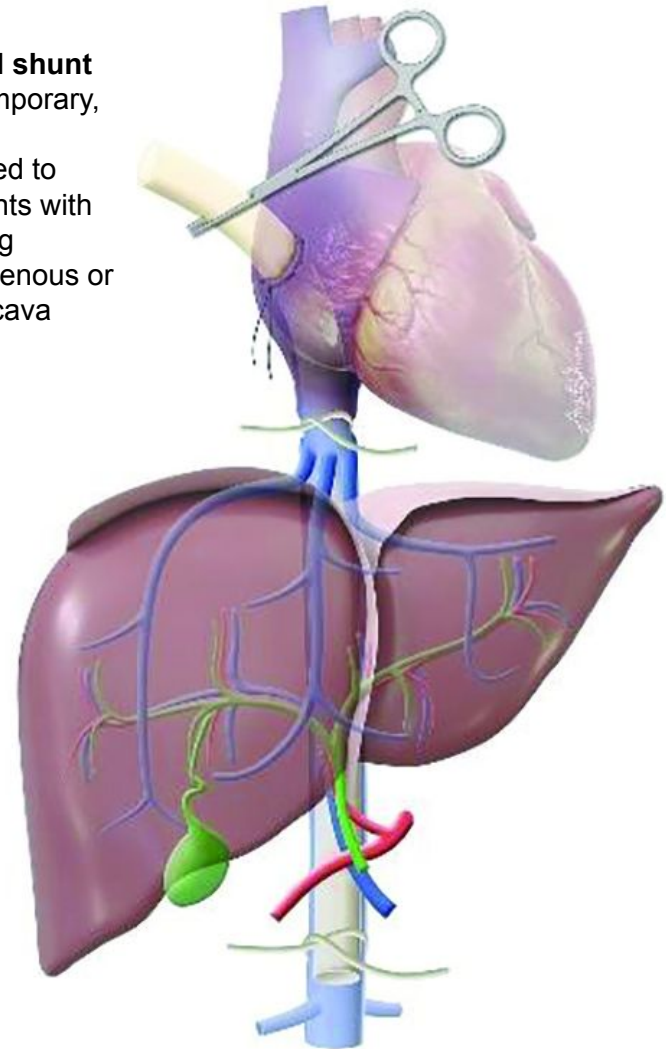


The Pringle maneuver is a surgical technique used during liver resections or trauma to control bleeding by temporarily clamping the hepatoduodenal ligament—containing the portal vein and hepatic artery—via a clamp or tape.



The Heaney maneuver is a surgical technique for severe liver trauma that achieves total vascular isolation of the liver to control bleeding.

An atriocaval shunt (ACS) is a temporary, intraoperative procedure used to salvage patients with life-threatening juxtahepatic venous or inferior vena cava (IVC) injuries.



Approach

- Zone 3
 - **Non-penetrating injuries to zone 3 do not need exploration unless an expanding haematoma is present.**
 - **Penetrating injuries to this area should be explored** as injury to major vascular structures of the pelvis, rectum or ureters
 - Injuries to the **common or external iliac arteries is obtaining distal control with a Foley catheter** with inflated balloon.
- Porta/retrohepatic
 - Pringle manoeuvre: opening the hepatoduodenal ligament and occluding all three portal structures with either a vascular clamp or a Rummel tourniquet.
- Retrohepatic area
 - Contains the confluence of hepatic veins and retrohepatic IVC and, **if at all possible, should not be explored. Unless there is evidence of active 'in-your-face' haemorrhage – avoid opening haematoma in this area.**
 - Total hepatic isolation (**Heaney maneuver**) by controlling the porta, as well as infrahepatic and suprahepatic IVC.
 - Alternatively, control of massive retrohepatic haemorrhage might necessitate **atriocaval shunting** bypassing IVC flow into the right atrium (this manoeuvre would require a rapid sternotomy).

Control and repair

Some vascular structures should be repaired while other can be ligated

Table 26.4 Repair or ligate.

Vascular structure	Plan of action	Potential complications if vascular structure is ligated
Aorta	Repair	
Infrarenal IVC	Repair or ligate	Lower extremity venostasis, oedema, DVT
Suprarenal IVC	Repair or ligate	Same as infrarenal; also renal failure
Celiac	Ligate	
SMA	Repair or ligate	Bowel ischaemia
SMV	Repair or ligate	Bowel ischaemia
Portal vein	Repair or ligate	Bowel ischaemia
Hepatic artery	Repair or ligate	Cholecystectomy if ligated
Common iliac artery	Repair or ligate	Will need extra-anatomic revascularisation of extremity
External iliac artery	Repair or ligate	Will need extra-anatomic revascularisation of extremity
Internal iliac artery	Ligate	
External/internal iliac vein	Ligate	Oedema and DVT
Renal artery	Repair or perform nephrectomy	
Left renal vein	Ligate	
Right renal vein	Repair or perform nephrectomy	

IVC, inferior vena cava; SMA, superior mesenteric artery; SMV, superior mesenteric vein; DVT, deep vein thrombosis.

Control and repair

- Arteries

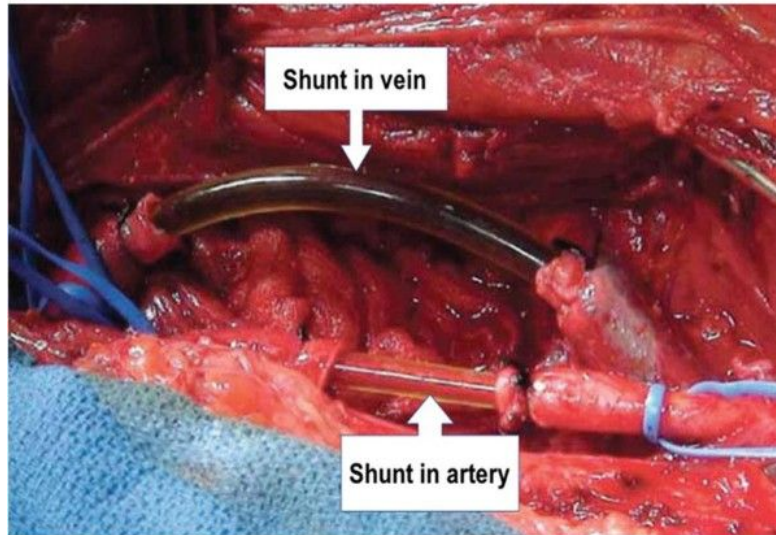
- Once the area of injury is identified, **proximal and distal control should be obtained around the area prior to haematoma 'entry' or repair.**
 - Major arterial injuries typically need to be controlled with **vascular clamps.**
 - Simple **suture.**
 - Full anastomosis
 - An interposition graft.

- Veins

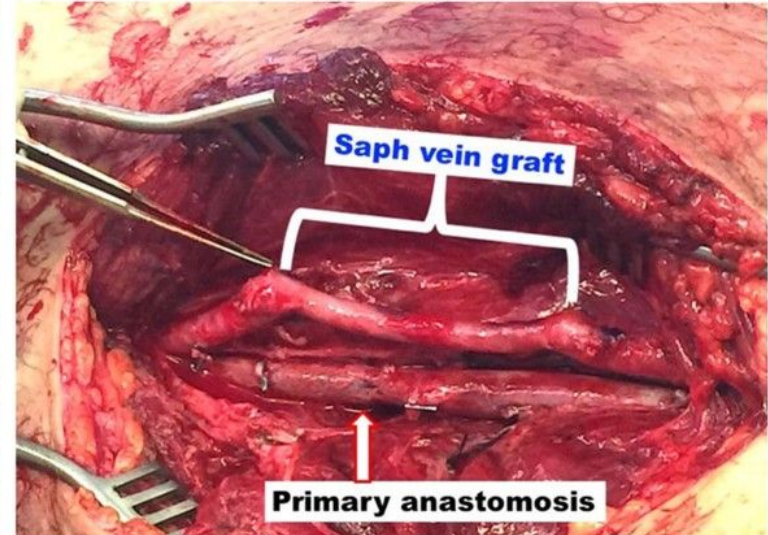
- Manual pressure.
- Sponges
- Ring forceps
- Satinsky

- Temporary repair
 - The superior mesenteric, common iliac and external iliac arteries are most suited for temporary bypass.

a



b



Solid organ injury

- Organs - can or cannot be removed
- The simplest approach is usually the best approach.

Table 26.5 Solid organ management.

Should be fixed (Conservative management)

Can be removed

Liver
Head of the pancreas

Spleen
Kidney
Distal pancreas

Solid organ injury

Liver

- Exposure
 - Mobilising the falciform ligament and triangular ligament on the side of the injury.
 - **If there is a suspicion for retrohepatic IVC injury, do not unroof this haematoma.**
- Packing
 - The key to liver packing is pressure from without and within. Packs should be placed both outside of the liver between the parenchyma and the thorax and between the liver and the internal structures, i.e. right retroperitoneum, hepatoduodenal ligament and the stomach
- The argon beam coagulator.
- 'liver stitch'
 - #1 Vicryl on a **large, blunt point needle**
 - Absorbable haemostatic material - GelfoamR wafer soaked in thrombin
 - Omental pedicle in the middle of this 'parenchymal sandwich'.
- Direct attack
 - When compression - The Pringle manoeuvre + suturing or clipping the bleeding vessels
- Left lateral sectionectomy and segment VI or VII segmentectomies.
 - Can be rapidly performed with a stapler.
- Interventional radiology
 - After packing the liver and applying a damage control dressing, the patient needs to be rapidly transported to the angiography suite for selective **embolisation** of a bleeding segment or lobe.

Solid organ injury

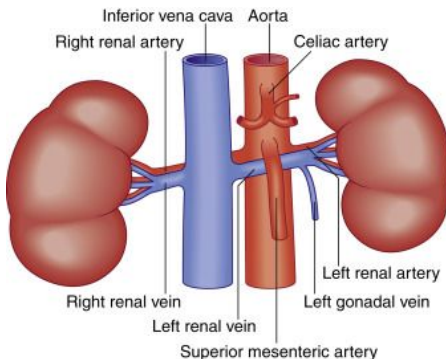
Spleen

- It is unlikely that a grade 3 splenic injury without a blush will require a splenectomy.
- The key to a trauma splenectomy is **quick mobilisation of the injured spleen towards midline**.
- All four ligaments will need to be divided prior to removal of the spleen, though sometimes the injury has taken down several for you.
- **The key manoeuvre in trauma splenectomy is division of the splenorenal ligament.** This allows for mobilisation of the spleen towards the midline
- Pitfalls of rapid division of gastrosplenic ligament ⇒ **iatrogenic injury to the tail of the pancreas or the stomach** ⇒ Bleeding as well as a pancreatic leak.
 - Avoid these injuries by not suture ligating (or clipping) too close to the stomach wall.
 - **Methodically evaluate the splenic bed** for any ongoing bleeding and control these with suture ligatures.

Solid organ injury

Kidney

- Grade 1–4 kidney injuries can almost always be managed nonoperatively.
- **Rapidly expanding zone 2 haematoma and suspicion for major vascular compromise might require a trauma nephrectomy.**
 - A good first step is **checking the other side for presence of contralateral kidney.**
 - Where none is present an attempt at **kidney preservation** might be entertained



- The key to rapid trauma nephrectomy is quick mobilisation of the organ towards midline.
 - Gerota's fascia can be quickly incised
 - Mobilise towards the midline.
 - Isolation of the vascular pedicle.
 - Remember that the renal veins overlay the renal arteries, and that the **right renal vein is very short.**
 - **longer left renal vein traverses over the aorta and can be proximally ligated given its collateral drainage.**
 - The quickest way to control renal vessels is either with **vascular clamps or a vascular stapler.**
 - If possible the renal artery and vein should be ligated **separately.**
 - Do not forget to isolate and ligate the **ureter**; this is usually performed as distal as possible.

Solid organ injury

- Pancreas
 - Tail can be safely and rapidly resected
 - The head of the pancreas is usually best managed non-operatively.
 - Exposure - through the gastrocolic omentum
 -
- Distal injury management
 - Distal pancreatectomy with splenectomy.
 - Proximal pancreatic margin ⇒ stapler.
 - Spleen preservation during a distal pancreatectomy is possible, but certainly requires extra time and should not be a part of a trauma laparotomy with exsanguination.
 - If identified, the **pancreatic duct can be oversewn** with a monofilament suture. Leave a drain in the pancreatic bed to control possible pancreatic leak.
- Proximal injury management
 - A full Kocher manoeuvre → mobilising the duodenal C-loop from the right towards the midline.
 - Bleeding controlled → monofilament sutures.
 - **A trauma Whipple should be avoided at nearly all costs.**
 - A reconstruction portion of this operation should be performed at re-exploration after damage control and not at the initial trauma laparotomy.
- SMA and SMV injury
 - Can be associated with pancreatic injury
 - Usually devastating and difficult to approach.
 - A rapid left and right medial visceral rotation will help optimise exposure.
 - **The surgical neck of the pancreas can be divided to provide direct access to these retropancreatic vessels.**

Bowel injury

Bowel injury and contamination control

- No patient should be transferred back to ICU with ongoing bowel leak.
- In cases of damage control surgery should complete in **one to one and a half hours after incision**. However, when cases do not warrant damage control manoeuvres you have more time to perform complete bowel anastomosis.
- Rapid control patient in extremis **your first priority is stopping the haemorrhage**.
-
- **Just leave the bowel alone and inspect it after the haemorrhage is stopped.**
- If **gross spillage** is noted, however, these areas of injury can be quickly controlled with **umbilical ties proximal and distal** to the defect.
- The whole bowel must be inspected.
- Any injuries can be controlled with Allis or Babcock clamps, or silk suture.
- Inspect the colon
- Do not forget that half of the colon circumference is **retroperitoneal**.
- If an injury is suspected at any specific location, **mobilise the colon** and inspect the whole circumference.
- Bowel length should be optimised and conserved.

Bowel injury

- If you are planning to close the abdominal fascia, you should establish bowel continuity.
- If there is an injury to the colon, consider a colostomy.
- Injuries to the right colon can be more frequently reconstructed with an anastomosis;
- Injuries to the **sigmoid and the rectum** usually require an **ostomy**.
- **However, if you are applying damage control techniques, then the bowel should be left in discontinuity.**
- Plans can then be made to re-explore the abdomen within 12–48 hours and reconstruction options should be considered at the next operation.

Stomach Injury

Stomach Injury

- Injury to the **back wall** of the stomach and to the **oesophagogastric junction** must be excluded
- **Stomach injuries are easy to control with suture or clamp and are usually easy to formally resect with a stapler.**

Duodenum

- Duodenum including the ligament of Treitz **should be carefully evaluated every time** there is penetrating injury to the pancreaticoduodenal area.
- **Simple suture control or pyloric exclusion (with a stapler) can be entertained at the initial operation;**
- **Formal repair should almost always be done at reexploration.**

Stomach Injury

Rectum

- The rectum needs to be evaluated after any penetrating injury to the pelvis.
- **Digital rectal examination**
- **Rigid proctosigmoidoscopy** should be performed to exclude rectal injury.
- **A diverting colostomy is the best treatment option.**

Diaphragm

- Both blunt and penetrating injuries can cause diaphragmatic injuries.
- The diaphragm should be **visually and manually inspected** by both surgeons to exclude an injury.
- Repair all diaphragmatic injuries with #1 non-absorbable suture.

Bladder

- Intraperitoneal bladder injuries are usually easily identified by the presence of a **urine leak** even if the bladder is decompressed by a urinary catheter. A simple **one layer repair with #3-0 absorbable** suture will usually work; however, some groups advocate a **two-layer closure**.
- **Mandatory bladder decompression** vary; a minimum of 5-7 days and/or a **contrast study should be performed before removing the Foley catheter**.

Abdominal Closure

- In trauma laparotomy there are two choices: primary abdominal fascial closure or an abbreviated laparotomy with application of damage control techniques.

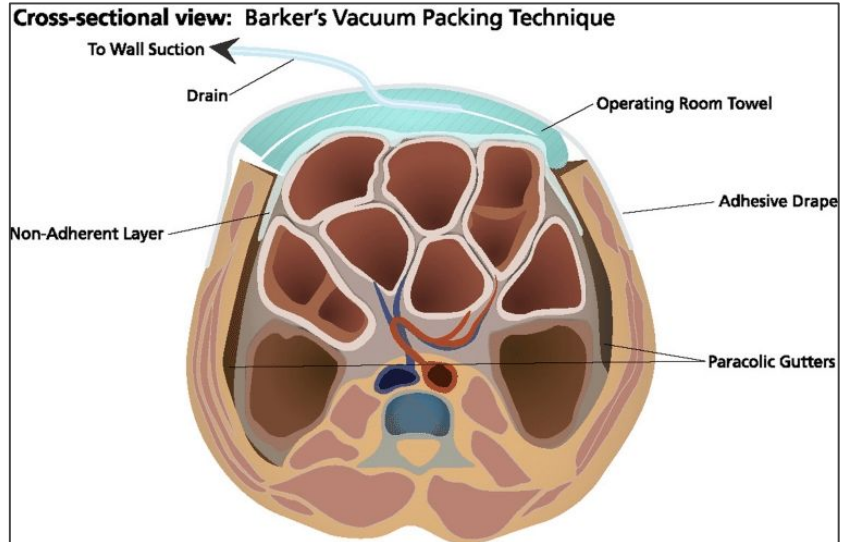
Table 26.6 Factors leading to damage control closure.

Physiologic	Injury pattern
Ongoing hypothermia	Combination of major vascular and bowel injury
Ongoing coagulopathy	Combination of solid organ and vascular and/or bowel injury
Ongoing acidosis	Need for re-exploration for evaluation and/or reconstruction of bowel
Ongoing haemodynamic instability	Multiple cavity injury

Abdominal Closure

- Primary fascial closure
 - Running #1 looped polydioxone (PDS II) sutures;
 - One from each side of the incision with a knot just above the umbilicus
 - The subcutaneous tissues should be irrigated and skin edges re-approximated with staples.
- Indications of the laparostomy:
 - Lethal triad
 - Combination of major vascular and hollow viscus injuries
 - Exsanguination from numerous structures
 - Questionable bowel viability should also be re-examined with a **'second look' laparotomy**.
- Damage control
 - Towel clips, running suture and Bogota bag (intravenous fluid bag) have all been described as **quick and easy closure** methods when employing damage control.
 - Many units prefer the **vacuum-pack** abdominal closure technique. This is simple and fast.
 - First layer is a **bowel bag** → underneath the fascia
 - Second layer is a **moistened surgical towel** tucked just under the fascia edges and overlaid with
 - Two flat-fluted Jackson-Pratt drains which will be placed to suction.
 - An optional surgical towel can be placed on top of the drains.
 - Lastly an Ioban antimicrobial **adhesive drape** is used to seal the contents of the vacuum-packed abdomen





Abdominal compartment syndrome

