Injuries to the Great Vessels of the Abdomen

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Findings on PE depend on whether a contained hematoma or active hemorrhage is present.

Those with contained hematomas may have only modest hypotension.

Those with active IP hemorrhage have significant hypotension associated with abdominal distension.
Introduction

• Secondary to penetrating wounds in 90 to 95% of cases

• Often accompanied by injuries to multiple intra-abdominal organs

• Occur in one of three zones of the RP or in the portal-retrohepatic area of the RUQ
Injuries in Zone 1
Supramesocolic

- It is helpful to divide midline RP hematomas into supra- and infra-mesocolic

- With hematoma or hemorrhage in this area suspect injuries to
  - suprarenal aorta
  - celiac axis
  - proximal SMA
  - proximal renal artery
Approach

- Left medial visceral rotation
- Allows visualization of the entire abdominal aorta from the aortic hiatus to the common iliac arteries
- Can be helpful to transect the left crus at the 2 o’clock position
  - exposes distal descending thoracic aorta
  - cross-clamp
Approach

- Active hemorrhage can be temporarily controlled by packing or applying an aortic compression device
- Divide lesser omentum, retract stomach and esophagus to the left
- Dissect just below aortic hiatus of diaphragm to expose supraceliac aorta
Technical Pearl

• Cross-clamping of the diaphragmatic or supraceliac abdominal aorta in a patient with hemorrhagic shock results in severe LE ischemia

• Restoration of flow then compounds the ischemic insult with a reperfusion injury that develops in the muscle compartments below the knee
Technical Pearl

- **STRONGLY CONSIDER** prophylactic 4-compartment fasciotomies prior to leaving the OR in these patients
Management

• Injuries to branches of the celiac axis are often difficult to repair because of the amount of dissection required to remove dense neural and lymphatic tissue.

• Injuries to the common hepatic artery may be repaired either via lateral arteriorrhaphy, resection+anastomosis or vein graft.
Management

- OK to ligate proper hepatic artery proximal to GDA origin
  - extensive collateral flow from midgut to liver

- When the entire celiac axis is injured, it is best to ligate all three vessels and forgo any attempt at repair
SMA

- Injuries are managed according to the anatomic level
- For injuries beneath neck of the pancreas, one may have to transect the pancreas to gain proximal control
- Another option is left medial visceral rotation with clamping of the origin of the SMA
- Often associated with pancreatic injuries
SMA

• Beware post-op pancreatic leak near arterial repair
• Option includes ligation of the injured vessel with interposition graft from distal infrarenal aorta to SMA
• Soft tissue must be approximated over aortic suture line of the graft to prevent an aortoenteric fistula
• Damage control laparotomy
• Resect injured area and insert intraluminal shunt to maintain midgut flow
• When ligation is indicated for more distal injuries, segments of the ileum or even right colon may have to be resected secondary to ischemia
SMA

- Survival rate is approximately 55 to 60% overall

- Only 20 to 25% when any form of repair more complex than lateral arteriorrhaphy is necessary
SMV

- Repair can be *DIFFICULT* because of proximity uncinate process and close association with the SMA.
- Patients *CAN* tolerate ligation *PROVIDED* vigorous post-op fluid resuscitation is instituted immediately.
SMV

- Ligation is followed by swelling and discoloration of the midgut suggestive of impending ischemia

- Survival ranges from 36 to 71% depending on the presence of other vascular injuries
Inframesocolic

• Lower area of midline RP in zone 1
• With hematoma or hemorrhage in this area suspect injuries to
  – infrarenal abdominal aorta
  – IVC
Approach

- Similar to that for infrarenal AAA
- Transverse mesocolon pulled up toward patient’s head
- Eviscerate small bowel to right side of the abdomen
- Open midline peritoneum until left renal vein is exposed
- Proximal cross-clamp is placed inferior to this vessel
Technical Pearl

• When the entire inframesocolic area is distorted by the presence of a large pulsatile hematoma, remember that the hole in the infrarenal abdominal aorta is under the highest point in the hematoma
  – Mt. Everest phenomenon
Because the RP tissue is thin, an important adjunctive measure after aortic repair is to mobilize gastrocolic omentum to cover the repair

- viable omental pedicle to cover aortic suture line
- prevent post-op aortoduodenal fistula
Injuries to the IVC
Management Principles

- **SUSPECT** with hematoma and intact aorta
- Usually more prominent on the right
- Right medial visceral rotation + Kocher
  - visualization of the entire caval system from the confluence of the iliac veins to the suprarenal cava below the liver
- For proper exposure, the loose RP fatty tissue must be dissected away from the wall of the vessel
- Judd-Allis
Approach

- To control injury at confluence of iliac veins it may be necessary to divide right common iliac artery
- Mobilize aortic bifurcation to left
- Yields a better view of common iliac veins and proximal IVC
- Repair common iliac artery
Operative Approach

- Will often hear about visualizing posterior injuries by extending anterior injuries
- Often easier to roll the cava to one side to complete a continuous repair
- When both anterior and posterior injuries have been repaired, there is usually a significant degree of narrowing
- Leads to post-op occlusion
Technical Pearl

• Ligation of the infrarenal IVC can be done in patients with exsanguinating injuries in whom a complex repair would be necessary
  – both thigh and calf fasciotomies
Injuries in Zone 2
Zone 2

- With hematoma or hemorrhage in this area suspect injuries to
  - renal artery
  - renal vein
  - kidney
Kidney

• If the hematoma is contained and non-expanding, it should be left alone
• If there is active hemorrhage, no central venous control is necessary
• RP lateral to the kidney is opened and the kidney elevated into the abdominal incision
• Renal pedicle clamp is then applied
Injuries in Zone 3
Zone 2

- With hematoma or hemorrhage in either lateral pelvic area suspect injuries to
  - iliac artery
  - iliac vein
Management

• When lateral pelvic hematoma or hemorrhage is noted after penetrating trauma, manual compression should be maintained until proximal and distal vascular control is obtained.

• Proximal common iliac arteries are exposed by eviscerating SB to right and dividing RP over aortic bifurcation.
Management

- Distal control is most easily obtained where the external iliac artery and vein come out of the pelvis proximal to inguinal ligament.

- Even with proximal and distal control, there is often back-bleeding from the internal iliac artery.
Technical Pearl

• Proximally both the AA and IVC are cross-clamped just above bifurcation and distally both external iliac artery and vein are cross-clamped
  – total pelvic vascular isolation
  – for transpelvic bilateral iliac vascular injuries
Technical Pearl

• Ligation of either the common or external iliac artery leads to a greater than 50% amputation rate in the post-op period
Injuries to the Iliac veins

• Hemorrhage from these injuries can usually be controlled by means of manual compression

• Best repaired with lateral venorrhaphy

• For patients with narrowing or occlusion, as well as for those in whom ligation was necessary to control exsanguinating hemorrhage, the use of elastic compression wraps and elevation is mandatory
Injuries in the Porta Hepatis or Retrohepatic Area
Porta Hepatis

• With hematoma or hemorrhage in the area of the portal triad in the RUQ suspect injuries to
  – portal vein
  – hepatic artery
  – vascular injury combined with an injury to the CBD
• If hematoma is present, proximal hepatoduodenal ligament should be occluded before the hematoma is entered
  – Pringle maneuver

• If possible, a vascular clamp should be placed on the portal structures at their entrance into the liver
Technical Pearl

• Ligation of either the right or left hepatic artery is ordinarily well tolerated
  - extensive collateral arterial flow and perfusion of oxygenated blood through ipsilateral branch of portal vein
  - may compromise injured hepatic tissue
  - ligation of right hepatic artery should be followed by cholecystectomy
Portal Vein

• Because of its large size and posterior position in the hepatoduodenal ligament, injuries can be lethal

• Mobilize CBD to left and cystic duct superiorly + extensive Kocher = excellent visualization of any injuries above superior border of pancreas
Technical Pearl

• As with ligation of the SMV, it is necessary to infuse significant amounts of crystalloid to reverse the transient peripheral hypovolemia that occurs secondary to splanchnic hypervolemia following portal vein ligation.
Retrohepatic Area
What to Look For

- With retrohepatic hematoma or hemorrhage suspect injuries to
  - retrohepatic vena cava
  - hepatic vein
  - right renal blood vessel
  - overlying liver
Retrohepatic Hematoma

- Non-expanding hematoma that is not associated with right perirenal area = tamponaded injury to retrohepatic cava or hepatic vein
  - perihepatic packing
  - 24 to 48 hours
  - STRONGLY CONSIDER
Options

- Retrohepatic caval injuries
  - mobilize right lobe and visualize injury
  - atriocaval shunt
  - total vascular isolation
Damage-Control Laparotomy
Patients with injuries to the great vessels are ideal candidates for DCL

- Hypothermic, acidotic and coagulopathic

- Temporary shunts
What You Need to Know

• Aortic control is easier said than done
• Exposure of actively bleeding injuries is easier said than done
• Always gain proximal and distal control before opening a hematoma
• Cover your repairs
• Let anesthesia know what you are doing
What You Need to Know

• 2 suctions are better than 1
• Much easier to control significant intra-abdominal hemorrhage with 3 people that know what they are doing
• Don’t be afraid to call for help
• Know your outs