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Chapter

Blunt Injury Abdomen

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Abstract

Road traffic accidents are one of the leading causes of mortality. Blunt injury abdomen contributes to the mortality in road traffic accidents second to head injury. The mechanism of injury in road traffic accidents are due to blunt force created by collision between the patient and the external forces, acceleration and deceleration forces acting on the person's internal forces. The common solid organs involved in blunt abdominal trauma are Spleen, Liver, and Kidney. Mesenteric tear and isolated small bowel injuries can also occur. Blunt abdominal trauma is one of the very common emergencies in the emergency department. High degree of suspicion and watchfulness, regular examination, imaging and investigations are needed to diagnose blunt injury abdomen. E-FAST is the emergency screening tool used to diagnose intra-abdominal injuries in emergency department even in hemodynamically unstable patient. The treatment will depend on the hemodynamical status, whether stable or unstable. Hemodynamically unstable patient with positive E-FAST will be taken up for emergency exploration while stable patient will undergo further imaging and investigation to plan the management. The chapter will discuss about the grades of injuries in spleen, Liver, mesentery and retroperitoneum. It will also discuss about the various diagnostic and treatment modalities available and when and where to use them to improve the quality of management. This chapter will be useful for the surgical postgraduates and young budding surgeons and trauma surgeons.

Keywords: Blunt injury abdomen, AAST grading, Splenic injury, Liver injury, Retroperitoneal hematoma

1. Introduction

Blunt injury abdomen is a common emergency in emergency department which commonly results from Road traffic accidents, assaults or accidental falls. Since the occurrence of road traffic accidents are increasing, they are the leading causes of global disease burdens. According to Global status report on Road safety 2013, more than 1.3 lakh people died on Indian roads, giving India the dubious honor of topping the global risk of fatalities from road crashes. Head injury, fractures and Blunt injury abdomen are the common causes of death in road traffic accident injuries.

2. Mechanism of blunt injury abdomen

Intraabdominal injuries secondary to blunt force are due to collisions between the injured person and external forces and the acceleration and deceleration forces acting on the person's internal organs.
The mechanisms are:

a. Deceleration:

Rapid deceleration causes differentiating movement among adjacent structures. As a result, shear forces are created and causes injury to hollow, solid visceral organs and vascular pedicles at relatively fixed points of attachment. Eg: Hepatic tear along ligamentum teres, as bowel loops travel from their mesenteric attachments, mesenteric tears with resultant splanchnic vessel injuries can result.

b. Crushing:

Intra-abdominal contents are crushed between anterior abdominal and vertebral column. Solid viscera like spleen, liver and kidneys are more vulnerable.

c. External compression:

External compressive forces like direct blows or external compression against a fixed object results in a sudden and dramatic rise in intrabdominal pressure which result in rupture of hollow viscus, in accordance with the principles of Boyle’s law. The liver, spleen, small intestine and large intestine are most frequently injured organs in increasing order of frequency.

3. Clinical examination

Blunt injury abdomen will be associated with other injuries like head injuries or fractures. So the presenting symptom will vary. For Blunt injury alone- patient will present with abdominal distension, abdominal pain or hemodynamic instability. Once the patient enters into the emergency room - primary survey is done. Primary survey consists of:

• AIRWAY

• Breathing - Oxygen saturation
• Circulation - Pulse - rate, volume and Blood pressure
• Look for Glasgow coma scale

Followed by Abdominal examination:

• Inspection - pattern contusions, abrasion, abdominal distension
• Palpation - tenderness/guarding/rigidity/rib fracture/pelvic fracture
• Percussion - for free fluid and liver dullness obliteration
• Auscultation - bowels sounds

Clear the airway, resuscitate for breathing, insert wide bore IV needle for infusion or insert a central venous catheter. The Advanced Trauma Life Support (ATLS) definition considers as “unstable” the patient with; blood pressure < 90 mmHg and heart rate > 120 bpm, with evidence of skin vasoconstriction (cool, clammy, decreased capillary refill), altered level of consciousness and/or shortness of breath.
If the patient is hemodynamically unstable, stabilize first with crystalloids, colloids or blood transfusion whichever is applicable and do e-FAST. If there is any evidence of free fluid in extended FAST - shift the patient directly to EOT. If the patient is hemodynamically stable and primary survey is negative, you can shift the patient to CT scan and review. A strong suspicion is needed to diagnose blunt injury abdomen.

4. Splenic injury

It is the most common visceral injury from violence. Likelihood of severity is more with diseased spleen. Splenic injury is commonly associated with left hemotherax, fracture of left lower ribs, injuries to tail of pancreas, left lobe of liver, left kidney or left colon. Direct compression of spleen causes parenchymal injury. Rapid deceleration causes tear to splenic parenchyma. Direct blows to the abdomen (domestic violence, or leisure and play activities) cause splenic rupture.

4.1 Clinical presentation

- Hilar injury – Rapid development of shock and deteriorates fast (even death can occur)
- Other injuries – Features of shock (pallor, tachycardia, restlessness, tachypnea, anxiety, hypotension, decreased capillary refill and decreased pulse pressure)
- Abdominal Pain, distension, tenderness and abdominal rigidity in LUQ and Kehr’s sign may be positive. (Kehr’s sign – Clot collected under left diaphragm irritates it and the phrenic nerve (C3, C4) causing referred pain in left shoulder 15 minutes after foot end elevation)
- Delayed Splenic Rupture: Latent period of Baudet - patient has no signs and symptoms for hours to days and presents later. Tends to occur 4–8 days after trauma. It may be due to expanding subcapsular hematoma, Clot disruption, Pseudocyst rupture or Pseudoaneurysm/AV fistula rupture.

4.2 According to American Association for the Surgery of Trauma splenic injury scale

<table>
<thead>
<tr>
<th>Grade</th>
<th>Type Of Injury</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Laceration</td>
<td>Capsular tear, &lt; 1 cm depth</td>
</tr>
<tr>
<td></td>
<td>Hematoma</td>
<td>Involving &lt;10% TSA of spleen</td>
</tr>
<tr>
<td>II</td>
<td>Laceration</td>
<td>1–3 cm parenchymal depth which does not involve a trabecular vessel</td>
</tr>
<tr>
<td></td>
<td>Hematoma</td>
<td>Subcapsular, Involving 10–50% TSA of spleen, Intra parenchymal, &lt;5 cm in depth</td>
</tr>
<tr>
<td>III</td>
<td>Laceration</td>
<td>&gt;3 cm parenchymal depth or involving trabecular vessels</td>
</tr>
<tr>
<td></td>
<td>Hematoma</td>
<td>Subcapsular involving &gt;50% of TSA of spleen or expanding; ruptured subcapsular or parenchymal haematoma</td>
</tr>
<tr>
<td>IV</td>
<td>Laceration</td>
<td>Segmental or hilar (&gt;25% devascularization)</td>
</tr>
<tr>
<td>V</td>
<td>Laceration</td>
<td>Shattered spleen</td>
</tr>
<tr>
<td></td>
<td>Vascular</td>
<td>Hilar vascular injury which devascularizes the spleen</td>
</tr>
</tbody>
</table>

4.3 Management of Splenic injury

It depends on the haemodynamic stability and associated injuries. Different ways of treatment are:
1. Non-operative management of splenic injury

2. Operative management

3. Splenic artery angioembolization

Patients who have diffuse peritonitis or who are hemodynamically unstable (a positive FAST examination or positive DPL) following blunt abdominal trauma should be taken urgently for exploratory laparotomy. A routine laparotomy is not indicated in the hemodynamically stable patient without peritonitis presenting with an isolated splenic injury. Factors such as patient age, grade of injury, and presence of hypotension need to be considered in the clinical management of these patients. For patients with NOM, an abdominal CT scan with IV contrast should be performed to identify and assess the severity of injury to the spleen. Angiography should be considered for patients with AAST grade III injuries. Presence of a contrast blush, moderate hemoperitoneum or evidence of ongoing splenic bleeding is an indication for splenectomy. Nonoperative management of splenic injuries should only be considered in an environment that provides capabilities for continuous monitoring like serial clinical evaluations, serial HB estimation, serial radiological screening and availability of an emergency operating room at any given time [1]. If there is fall of vitals or fall of hematocrit values or evidence of expanding haematoma or ongoing bleeding, then the patient is shifted for emergency laparotomy.
5. Liver injury

Liver is the most common organ injured in blunt and penetrating injuries. Its anterior location in the abdomen, fragile parenchyma makes it susceptible to injury from blunt forces. Its fixed location under the diaphragm also makes it susceptible to shear forces from deceleration injuries. The vasculature in the liver is made up of large, but thin-walled vessels with high blood flow.

According to AAST Liver trauma scale.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Type Of Injury</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Laceration</td>
<td>&lt; 1 cm depth, non-bleeding</td>
</tr>
<tr>
<td></td>
<td>Hematoma</td>
<td>Subcapsular, Non-expanding, Involving &lt;10% TSA of liver</td>
</tr>
<tr>
<td>II</td>
<td>Laceration</td>
<td>1 – 3 cm depth, &lt;10 cm in length</td>
</tr>
<tr>
<td></td>
<td>Hematoma</td>
<td>Subcapsular, Involving 10–50% TSA, non-expanding</td>
</tr>
<tr>
<td>III</td>
<td>Laceration</td>
<td>&gt;3 cm depth</td>
</tr>
<tr>
<td></td>
<td>Hematoma</td>
<td>Subcapsular –Involving &gt;50% of TSA, intraparenchymal &gt;2 cm, expanding</td>
</tr>
<tr>
<td>IV</td>
<td>Hematoma</td>
<td>Bleeding intraparenchymal rupture</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>Involving 25–50% of the lobe</td>
</tr>
<tr>
<td>V</td>
<td>Laceration</td>
<td>Involving more than 50% of the lobe</td>
</tr>
<tr>
<td></td>
<td>Vascular</td>
<td>Juxta hepatic veins, main hepatic veins or retro hepatic area</td>
</tr>
<tr>
<td>VI</td>
<td>Vascular</td>
<td>Hepatic avulsion</td>
</tr>
</tbody>
</table>

5.1 NON-operative management [NOM] of traumatic liver injury

Blunt trauma patients with

- hemodynamic stability
- absence of other internal injuries requiring surgery

Can undergo non operative management irrespective of grades of liver injury. NOM should not be used for patients with hemodynamic instability and peritonitis. NOM should be adopted in centers with facilities for intensive care monitoring, angiography, an immediately availability of OR and immediate access to blood products [2, 3]. CT angiogram should be done for patients considered for NOM. If there is any blush in CT angiogram, consider angioembolization. The patients on NOM should be continuously monitored for vitals, hematocrit, abdominal girth and the development of peritonitis.

Complications of NOM:

- Bleeding
- Abdominal compartment syndrome
- Infections (abscesses and other infections)
- Biliary complications (bile leak, hemobilia, bilioma, biliary peritonitis, biliary fistula) [2, 3]
- Liver necrosis
• Re-bleeding or secondary hemorrhage (rupture of a subcapsular hematoma or a pseudo-aneurysm)

If there is fall in BP or hematocrit values or development of any signs of peritonitis, the patient should be immediately taken up for laparotomy.

NOM in penetrating liver trauma

• Hemodynamic stability and

• Absence of peritonitis, significant free air, localized thickened bowel wall, evisceration, impalement [2, 3]

5.2 Operative Management

Patients should undergo OM in liver trauma (blunt and penetrating) in case of hemodynamic instability and concomitant internal organ injury. The primary intention is to control hemorrhage and bile leak. Major hepatic resections should be avoided in emergency and should be considered in subsequent management.

Intraoperative management [2, 4] includes:

• hepatic manual compression and hepatic packing

• usage of energy sources like bipolar cautery, argon laser beam etc.,

• ligation of vessels in the wound

• hepatic debridement

• balloon tamponade

• shunting procedures

• hepatic vascular isolation

For patients undergoing hepatic packing, temporary abdominal closure can be done to prevent abdominal compartment syndrome. Selective hepatic artery ligation can be considered for patients with massive hemorrhage. Associated portal vein injuries should be repaired. Portal vein ligation can lead to hepatic necrosis and bowel edema. Hepatic resections can be done for severe injuries with uncontrolled bleeding which is not controlled by any of the above means.

6. Pancreatic injury

Most of the pancreatic injuries will be associated with spinal fracture at the level of first and second lumbar vertebrae. Isolated injuries of pancreas after blunt abdominal trauma noted in 20% of pancreatic injuries. Head of pancreas injuries may be associated with injuries of stomach, duodenum and transverse colon. Injuries of the body and tail of pancreas may be associated with injuries to the stomach, transverse colon, splenic flexure of the colon, splenic vessels and spleen.

6.1 Clinical presentation

Direct blow with compression of upper abdomen against spine will be the most common cause of the pancreatic injury. Many patients have minimal clinical
symptoms and signs when evaluated after trauma. Pancreatic injuries will be missed if not properly looked for because of minimal symptoms and signs. When symptoms present, the most common is deep epigastric pain associated with nausea and vomiting. Hyperamylasemia is not a precise marker for pancreatic injury. Hyperamylasemia is present in 30–40% of patients admitted with trauma and the progressive rise in the amylase level over the first 24 to 48 hours of hospitalization strongly suggestive of pancreatic injury. CECT using 128 slice scanners is the diagnostic modality of choice. ERCP can be used to rule out injury to the main pancreatic duct.

6.2 CT findings in patients with suspicious of pancreatic injuries are

- Fluid in the lesser sac
- Fluid between pancreas and splenic vein
- Hematoma of transverse mesocolon
- Thickening of left anterior renal fascia
- Duodenal hematoma or laceration injury to spleen, left kidney, left adrenal gland
- Chance fracture of lumbar spine

6.3 CT findings which are diagnostic of pancreatic injuries are:

- Parenchymal hematoma or laceration
- Obvious transection of the parenchyma
- Disruption of head of pancreas
- Diffuse swelling characteristic of post traumatic pancreatitis [5].

6.4 Pancreas Organ Injury Scale of the American Association for the Surgery of Trauma

<table>
<thead>
<tr>
<th>Grade</th>
<th>Type Of Injury</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Hematoma</td>
<td>Minor contusion without duct injury</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>Superficial laceration without duct injury</td>
</tr>
<tr>
<td>II</td>
<td>Hematoma</td>
<td>Major contusion without duct injury or tissue loss</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>Major laceration without duct or injury or tissue loss</td>
</tr>
<tr>
<td>III</td>
<td>Laceration</td>
<td>Distal transection or parenchymal injury with duct injury</td>
</tr>
<tr>
<td>IV</td>
<td>Laceration</td>
<td>Proximal transection or parenchymal injury involving ampulla</td>
</tr>
<tr>
<td>V</td>
<td>Laceration</td>
<td>Massive disruption of pancreatic head</td>
</tr>
</tbody>
</table>

6.5 Management of isolated pancreatic injuries

In hemodynamically stable patient, pancreatic contusions (AAST grade I), minor capsular injuries, and traumatic pancreatitis can be treated without drainage [6]. Most other injuries require some sort of drainage.
AAST grade - I:
• Observation
• Omental pancreateorrhaphy with simple external drainage

AAST grade - II:
• Simple external drainage or Omental pancreateorrhaphy and drainage

AAST grade - III:
• Distal pancreatectomy ± splenectomy
• Roux-en-Y distal pancreateojunostomy

AAST grade - IV:
• Pancreatoduodenectomy
• Roux-en-Y distal pancreateojunostomy
• Anterior Roux-en-Y pancreatojejunostomy
• Endoscopically placed stent and simple drainage in damage control situations

AAST grade - V& VI:
• Pancreatoduodenectomy

Complication rates after operative treatment of pancreatic injuries range from 26–86%. The most common postoperative infectious complication and the leading cause of morbidity in patients with pancreatic injuries is an intra-abdominal abscess. A pancreatic fistula is the most common pancreatic complication after operative repair of a major injury [5, 6].

7. Renal injury

Most common mechanisms which cause renal injury are motor vehicle collision, falls, vehicle-associated pedestrian accidents, sports and assault. Frontal impact caused by acceleration of the occupants into the seat belt or steering wheel or side impact injuries occur when the vehicle side panel intrudes into the compartment and hits the occupant causes renal injury. Frontal and side airbags reduce the risk of renal injury by 45.3% and 52.8% respectively. Sudden deceleration or a crush injury may result in contusion and laceration of the renal parenchyma. Penetrating renal injuries occur as a result of gunshot or stab wound. Incidence of urological tract injury following abdominal trauma is approximately 10%. Renal trauma comprises of 1–5% of all trauma.

7.1 Clinical presentation

Patient may present with localized pain or tenderness or diffuse tenderness. Retro peritoneal bleeding may lead to abdominal distention, ileus, nausea and vomiting. Features of hypovolemic shock may be present. Ecchymosis may be present.
over the flank on the affected side. Lower rib fractures or pelvic fractures may be frequently associated with renal injury. A palpable mass may represent a large retroperitoneal hematoma or perhaps urinary extravasation. If the retroperitoneum has been torn, free blood may be noted in the peritoneal cavity but no palpable mass will be evident. Haematuria may be present [7].

7.2 Investigations

Contrast Enhanced CT: is the gold standard for evaluation of stable patients with renal trauma. Absence of enhancement on contrast administration or presence of parahilar hematoma suggests renal pedicle injury and is difficult to directly visualize renal vein injury. Standard CECT scans may miss collecting system injury which is best detected by repeating the scan 10–15 minutes after contrast injection. CT imaging is both sensitive and specific for demonstrating parenchymal lacerations and urinary extravasations, delineating segmental parenchymal infarcts, determining the size and location of the surrounding retroperitoneal hematoma and/or associated intra-abdominal injury (spleen, liver, pancreas, and bowel). Renal artery occlusion and global renal infarct are noted on CT scans by lack of parenchymal enhancement or a persistent cortical rim sign.

Angiography: Most common indication for arteriography is non-visualization of a kidney on IVP after major blunt renal trauma when a CT is not available. It is the test of choice for evaluating renal vein injury [10].

7.3 AAST grading of renal injury

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description Of Injury</th>
</tr>
</thead>
</table>
| I     | Contusion or non expanding subcapsular hematoma  
No laceration |
| II    | Non expanding peri renal hematoma  
Cortical laceration <1 cm deep without extravasation |
| III   | Cortical laceration >1 cm deep with extravasation |
| IV    | Laceration through cortico medullary into collecting system  
Vascular-segmental renal artery or vein injury with contained hematoma or partial vessel laceration or vessel thrombosis |
| V     | Laceration shattered kidney  
Vascular: renal pedicle or avulsion |

7.4 Non-operative management

Grade 1–4 blunt renal trauma, stable patients should be managed conservatively with bed rest, prophylactic antibiotics, and continuous monitoring of vital signs until haematuria resolves. Persistent bleeding represents the main indication for renal exploration and reconstruction.

7.5 Indications for operative exploration

• Hemodynamic instability due to renal hemorrhage is an absolute indication for renal exploration

• Grade V renal injuries in a stable patient

• Expanding or pulsatile peri-renal hematoma seen at laparotomy for associated injuries are other indications for renal exploration [7].
Goal of renal exploration following renal trauma is control of hemorrhage and renal salvage. Renorrhaphy or partial nephrectomy is used to manage parenchymal laceration. Attempt should be made for a watertight closure of collecting system. Raw areas should be minimized by using renal capsule, omentum or fibrin glue. Repair of Grade V renal injury is rarely successful and nephrectomy is usually the best option, except in case of a solitary kidney. Retroperitoneum should be drained following renal exploration.

7.6 Complications

Early complications occur within the first month of injury and can be bleeding, infection, peri-nephric abscess, sepsis, urinary fistula, hypertension, urinary extravasation and urinoma. Delayed complications include calculus formation, chronic pyelonephritis, hypertension, arteriovenous fistula, hydronephrosis, and pseudoaneurysms. Peri-nephric abscesses are best managed by percutaneous drainage. Delayed bleeding and arterio-venous fistula are managed by angiographic embolization. Treatment of hypertension is required if it persists, and could include medical management, excision of the ischemic parenchymal segment and vascular reconstruction, or total nephrectomy. Urinary extravasation after renal reconstruction often subsides without intervention as long as ureteral obstruction and infection are not present. Persistent urinary extravasation responds to stent placement or percutaneous drainage.

8. Mesenteric injury

Isolated mesenteric injury is rare. Mesenteric tear occurs as a result of deceleration injury. The tear in the mesentery may be longitudinal or transverse. Longitudinal tear is more common than transverse tear. Longitudinal tear can occur from the base of mesentery to the margin of the gut. The tear may be single or multiple. Longitudinal tear can be suture ligated without bowel resection if it does not extend up to the margin of the gut. Longitudinal tears can involve the root of mesentery and superior mesenteric vessels. Transverse tear is dangerous as it will cause gangrene of the segment of the bowel. Clinically isolated mesenteric injuries present as follows:

- Immediate - Due to bleeding. Signs of continuous bleeding, shock and peritoneal irritation are present, needing early laparotomy.
- Delayed- Due to bowel infarction. Delayed diagnosis of patients leads to intestinal infarction and requires bowel resection. The patient may present between 12 hours to 5 days after injury.
- Due to bowel stenosis or adhesion formation. Mesenteric vascular injury may induce chronic ischemia of the corresponding segment of small bowel, inducing secondary thickening of the bowel wall and intestinal occlusion and may present between 5 to 8 weeks after injury [8].

9. Traumatic retroperitoneal hematoma

Retroperitoneal injury can be due to blunt or penetrating trauma. Blunt trauma is caused by direct energy transfer. A penetrating injury is an injury that directly violates tissue planes. Retroperitoneum is divided into 3 zones:

Zone 1: The central retroperitoneum from the diaphragm superiorly to the bifurcation of the aorta inferiorly. It contains the inferior vena cava, origins of the
major renal and visceral vessels, duodenum, and pancreas. Blunt trauma to this region affects the duodenum and the pancreas to a greater extent, with vascular lesions being less frequent. Pancreatic injuries have an incidence that ranges between 1% and 12% of penetrating trauma, and 5% of blunt trauma. The most frequent complication is duodenal fistula.

**Zone 2:** Includes both lateral perinephric areas of the upper retroperitoneum from the renal vessels medially to the lateral reflection of the posterior parietal peritoneum of the abdomen (from the diaphragm superiorly to the level of aortic bifurcation inferiorly). Organs contained include adrenal glands, kidneys, renal vessels, ureter, and ascending and descending colon. Renal and adrenal injuries are common in this region.

**Zone 3:** Is inferior to the aortic bifurcation and includes the right and left internal and external iliac arteries and veins, distal ureter, and distal sigmoid colon and rectum. Mostly vascular injuries occur in this region. Iliac vessel injury occurs in this region [9].

9.1 Management

9.1.1 For penetrating injury

Zone 1 – Major vessel injury can occur. Exploration must be done.

Zone 2 – Selectively explore the kidney for active hemorrhage or an expanding hematoma. Mobilize the colon to rule out retroperitoneal colon injury and explore the ureters if in proximity to the wound.

Zone 3 – Explore as this is likely a major vascular injury.

9.1.2 For blunt injury

Zone 1 – Explore as this is likely a major vascular injury. The most frequent aortic injuries are infrarenal, while vena cava injuries are predominantly adrenal in origin. In the presence of hemodynamic stability and absence of contraindication, conservative management, including angioembolization, should initially be considered.

Zone 2 – Conservative treatment is the most widely accepted. Exploration will be done for an expanding hematoma or one that has failed the alternative methods of hemorrhage control like angioembolization or for the presence of associated injuries or when there is suspicion of ureteral injuries. Do not explore a contained, non-expanding hematoma [9].

Zone 3 – Do not explore and utilize a method for hemorrhage control, such as intraoperative preperitoneal packing or angioembolization. Iliac vessel injuries prevail in importance due to their associated high mortality. Angiography and venous ligation can be done. The management of bone injury is based on the multidisciplinary approach.
10. Conclusion

Blunt injury abdomen is a common abdominal emergency condition. High degree of suspicion and watchful screening and examination is needed to diagnose blunt injury abdomen.
References


[10] American Association for Surgery of Trauma – Grading for Spleen, Liver, Pancreas and Renal Injuries