Review Article

Assessment and management of the injured abdomen

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In many countries trauma remains the major cause of death in patients under 40 years of age. Severe blunt abdominal trauma occurs most often as a result of road traffic accidents but it is not uncommon in industrial injuries, civil violence or participation in sport. The death toll in the European Economic Community from road traffic accidents alone totals 50,000 per year. Furthermore, for every fatality there are 20 cases of serious injury. With improved transport services and vigorous resuscitative measures more of these critically ill patients are surviving long enough to reach the operating theatre for emergency surgery.

The wearing of automobile seat belts has not only reduced the mortality but also the frequency and severity of injuries. However, the belt itself may cause intra-abdominal injury, particular if misplaced pressure acts directly on the abdomen rather than on the chest and iliac bones. The commonest intra-abdominal injury is to the small bowel or its mesentery but other intra-abdominal organs are also at risk. Patients with seat belt marks should be admitted for observation. If there is persistent abdominal pain or

incipient paralytic ileus, significant injury should be strongly suspected.

In patients with multiple injuries, abdominal trauma may represent a major challenge in diagnosis and treatment. In other instances there may be no significant injury to the abdomen but this may be difficult to substantiate with certainty initially. Altered level of consciousness due to head injury, presence of concurrent chest or skeletal injuries, hypovolaemia and shock may add to the problems of diagnosis in cases of abdominal trauma.

A diagrammatic representation of a suggested scheme for the clinical management of patients with penetrating and non-penetrating injuries is given in Figure 1.

Blunt abdominal trauma

Inaccuracy of clinical evaluation

On the initial clinical assessment the diagnosis will in all probability be accurate in only 70–80% of cases. In those patients who have concomitant head injury, multiple trauma or are shocked on admission, the correct clinical diagnosis may be made in less than 60% (Bivins *et al.*, 1978).

In patients with blunt abdominal trauma in whom physical signs are absent or apparently trivial initially, significant lesions become manifest in up to one-third of cases (Bagwell & Ferguson, 1980). Thus, close observation and repeated physical examinations are of paramount importance.

Aids to diagnosis

Table I lists various investigations which may aid in the diagnosis of non-penetrating abdominal trauma. In some instances none of these will be feasible because of the necessity to provide immediate resuscitation and proceed to urgent laparotomy.

X-ray of the abdomen and chest may demonstrate free intra-peritoneal gas from a ruptured hollow viscus. Retroperitoneal rupture of the duodenum may

Figure 1 Suggested scheme for the clinical management of patients with abdominal trauma.

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Table I Blunt abdominal trauma*Aids to diagnosis:*

Abdominal and chest X-rays
Serum amylase
Paracentesis
Peritoneal lavage
Urinalysis
Urinary tract radiography
Radioisotope scans of liver and spleen
Ultrasonography
Computerized axial tomography
Gastrointestinal tract studies
Biliary tract studies

give rise to air bubbles around the right psoas and kidney, obliteration of the psoas margin, scoliosis or segmental ileus. Rupture of the diaphragm, more common on the left than the right, may be demonstrated by gas filled organs in the chest.

Four quadrant peritoneal aspiration using a fine needle is helpful when positive but negative results should not be allowed to cloud the clinical acumen of the surgeon or lead to complacency. Although the method is simpler than diagnostic peritoneal lavage it is much less accurate as a diagnostic procedure and in many centres has been abandoned. The recent modification whereby the peritoneal cavity is tapped in the paracolic gutter with the patient inclined to the side may lead to improved accuracy of the method.

Peritoneal lavage if expertly carried out is now accepted as a relatively safe diagnostic procedure and is accurate in up to 98% of cases in determining the presence or absence of intra-abdominal injury following blunt trauma (Fischer *et al.*, 1978). However, in cases of injury of the retroperitoneal portion of the colon, duodenum or pancreas, the technique is notoriously inaccurate. Likewise, isolated bladder and diaphragmatic rupture may yield misleading results. Potential complications of lavage include perforation of the small intestine and colon, injury to the mesenteric or iliac vessels, or to the bladder. In a prospective randomized trial undertaken by Pachter & Hofstetter (1981), the open method in which the catheter is inserted through the peritoneum under direct vision was shown to be safer and more accurate than the percutaneous method.

In patients with a suspected urinary tract injury, urinalysis and intravenous urography may reveal the type and degree of injury. The absence of excretion of the contrast by one of the kidneys may indicate a renal pedicle injury, warranting arteriography for confirmation.

In difficult cases, particularly those presenting with less acute signs, useful information may be obtained by employing more sophisticated radiological,

radioisotopic or ultrasonic techniques as aids to diagnosis. It should be stressed however that it is only in a relatively small percentage of cases of abdominal trauma that these latter techniques are indicated.

Penetrating wounds

Penetrating wounds are most often due to stabbing or gunfire. The size of the external wound bears little relationship to the depth of the penetration and the severity of internal injury. Since the diaphragm rises as high as the fourth intercostal space during expiration, any patient with a penetrating wound below this level anteriorly or the fifth intercostal space laterally or the sixth intercostal space posteriorly should be considered potentially at risk for a subdiaphragmatic injury. With gunshot wounds the bullet entering the chest at any level may pass in an oblique or vertical rather than a horizontal plane through the chest and hence enter the abdomen.

Plain X-rays of the abdomen may yield useful information following penetrating abdominal wounds. However, sinography in which a radio-opaque medium is used to outline the tract is unreliable in determining whether or not the peritoneum has been penetrated in stab injuries (Aragon & Eiseman, 1976). Furthermore, probing is inaccurate in determining the depth of the stab wound and may open up false tracts or introduce infection (Petersen & Sheldon, 1979).

Exploration is mandatory in all gunshot wounds of the lower chest and abdomen. When the missile has entered the peritoneal cavity, significant lesions are present in 92–98% of cases. Serious intraperitoneal injury due to shock waves may occur without penetration of the peritoneal cavity, especially in abdominal trauma caused by high velocity weapons.

The management of abdominal stab wounds is a more controversial topic. For many years most surgeons routinely explored stab wounds of the abdomen but in recent years many surgeons have adopted what they consider to be a more rational approach to management of such injuries.

When a distinct policy of selective exploration of abdominal stab wounds was adopted by Nance *et al.* (1974), their negative exploration rate fell from 53% to 11% and complication rate fell from 14% to 8%. In a large series of 403 cases of abdominal stab wounds reported by Wilder & Kudchadkar (1980), 216 patients were observed and only 16 of these subsequently came to surgery (all within 24 hours) with no obvious detrimental effects due to this period of delay. These authors relied very much on careful and repeated clinical examinations and only occasionally undertook peritoneal aspiration or lavage.

Surgery is clearly indicated if there is evidence of

evisceration, pneumoperitoneum, haemoperitoneum, peritoneal irritation or hypovolaemia and circulatory inadequacy for which there is no other obvious cause. Likewise, if blood appears from the stomach, rectum or bladder, exploration must be undertaken. On the other hand, if peritoneal signs are absent and local exploration of the wound under local anaesthesia reveals that the peritoneal cavity has not been violated, then laparotomy may be avoided.

Operative management

Loss of the tamponade effect occurs when muscle relaxants are given during induction of anaesthesia and more especially when the abdomen is opened. This may lead to increasing rate of blood loss and profound hypotension. Steps should be taken to combat this phenomenon by increasing the rate of intravenous infusion, aortic compression and, if necessary, direct intra-aortic infusion.

The abdomen is usually opened through a long mid-line incision, especially in blunt trauma although a right or left paramedian may be preferred in some penetrating wounds, depending on the site of the injury. Rapid assessment is made with a view to identifying and controlling any source of acute major haemorrhage. Sites of leakage of intestinal content are controlled and then a thorough assessment of the total intra-abdominal injury is undertaken.

The entrance and exit wounds caused by missiles should be thoroughly debrided and drained, the deeper layers being loosely approximated. The skin is closed by delayed primary suture. It should be remembered that following stabbing the wound may have been heavily contaminated by large bowel organisms which are deposited in the abdominal wound during withdrawal.

Pancreatico-duodenal injuries

Injury to the spleen or liver may be obvious; injury to the pancreas or retroperitoneal duodenum may be less so. Bile staining of the peritoneum or air bubbles in relation to the duodenum, ligament of Trietz or transverse mesocolon indicate the need for further exploration. Likewise, haematoma over the duodenum, along the base of the mesentery or adjacent to the greater curvature of the stomach should arouse suspicion of a potentially serious injury. If penetration of the region by a missile or instrument has occurred, exploration must be carried out with diligence.

Injuries of these organs vary from minor bruising to extensive pancreatico-duodenal disruption. The most significant aspect of all is whether or not there has been a major pancreatic duct involvement.

For minor contusions of the pancreas simple drainage is adequate. For moderate or severe injuries of the body of the pancreas involving the main pancreatic duct, distal pancreatectomy is preferable to more conservative options. While many lacerations of the duodenum may be adequately dealt with by direct suture in two layers, there are some cases of severe injuries to the duodenum and pancreatic head, in which repair procedures incorporating the use of a Roux loop of jejunum are recommended (Campbell & Kennedy, 1980). Other procedures such as duodenal diverticulisation which involves duodenal exclusion and gastric diversion have their advocates. Pancreatico-duodenectomy has a limited place in those patients in whom the head of the pancreas and duodenum have been shattered. Obviously in these circumstances this extensive operation carries a high mortality of the order of 50%.

Supplementary procedures such as decompression of the duodenum are beneficial and in some cases a feeding jejunostomy is desirable.

Hepatic injuries

By the time laparotomy is undertaken following abdominal trauma, 50% of cases of hepatic wounds have stopped bleeding. For these cases adequate drainage of the area is sufficient. Small superficial lacerations that are still bleeding are dealt with by local pressure or direct suture.

Deep central lacerations often present a major challenge. Insertion of deep mattress sutures which close the laceration externally but convert a deep crevice into an intrahepatic cavity is best avoided as this leads to intrahepatic collection of blood and bile with the likelihood of progress of infection, abscess formation and even the development of haemobilia. It may be possible to control bleeding by direct ligation but exploration in the depth of these wounds may lead to torrential haemorrhage. If temporary occlusion of the hepatic artery or one of its two main branches controls the bleeding then ligation of the appropriate vessel, as advocated by Aaron *et al.* (1975) may be a safer option.

Formal lobectomy is seldom warranted but if the lobe is completely shattered, there is no reasonable alternative to excision. Occasionally smaller areas of devitalised liver tissue may have to be removed. This may be achieved by the 'finger fracture' method which allows exposure and ligation of intact parenchymal vessels and bile ducts prior to their division.

Injuries to the hepatic veins or retrohepatic vena cava are highly lethal and are particularly difficult to manage surgically. If direct repair cannot be achieved on mobilisation of the liver, it may be necessary to use an intracaval shunt introduced via the right atrium following median sternotomy.

Decompression of the common bile duct after hepatic injury has its advocates and opponents. In isolated hepatic injury it is undertaken less often nowadays. If, however, severe hepatic trauma is associated with injury to the pancreaticoduodenal region, then ductal decompression should be considered.

Splenic injuries

For many years splenectomy has been the standard treatment following trauma to this organ. In 1952, King & Shumacker reported the occurrence of serious and highly lethal post-splenectomy infection in children. The case for conservation of the spleen in the young patient, where at all feasible, is now widely accepted. The risk of fulminating infection is less in the adult and also lower in the hitherto healthy person. If injury to the spleen is limited and the hilum is intact, then operative repair should be attempted, especially in the child or young adult, but it would be unwise to carry this conservation to the extreme in any age group.

Large bowel injuries

Right colon Stab wounds and some low velocity gunshot injuries of the right colon are suitable for closure by simple suture. More extensive gunshot injuries and severe contusion or rupture resulting from blunt injury require resection. Occasionally a high

velocity gunshot injury associated with marked hypotension and multiple intra-abdominal injuries particularly the pancreas and the duodenum, is best treated by resection and delayed anastomosis.

Left colon Minor wounds of the left colon may also be closed by simple suture if (i) there is little peritoneal soiling, (ii) if less than 4 hours has elapsed since the time of injury and (iii) if there are minimal associated injuries. Otherwise, it is wise to establish a concomitant proximal colostomy. More major wounds of the left colon are either exteriorized or resected. When resection with primary anastomosis is undertaken, a proximal colostomy is advised. Alternatively, following excision of the damaged segment, the proximal end may be brought out as an end colostomy and the distal end as a mucous fistula with a view to restoration of bowel continuity at a later date.

Rectum If feasible, the wound is closed, a proximal colostomy is formed, perirectal drainage is established and the faecal material is irrigated from the rectum.

The prognosis following large bowel injuries is enhanced by the use of metronidazole together with an aminoglycoside or a cephalosporin to help control infection. Nowadays mortality with isolated injury of the large intestine is relatively low. On the other hand, mortality and morbidity are increased with age, severe haemorrhagic shock, gross peritoneal contamination, multiple visceral injuries and undue delay in treatment (Parks, 1981).

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