UPPER ABDOMINAL INJURIES

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Introduction

The incidence of upper abdominal injuries is not confined to automobile users, but with the great increase in road traffic, the majority of these injuries result from road traffic accidents. There are various mechanisms by which this particular type of trauma may be produced; as a result, more than one viscus may be involved. One must beware of associated injuries to the chest, skull and skeleton. The problems of diagnosis in these cases are magnified by the necessity of establishing not only what kind of injury has taken place in the upper abdomen but whether there has been an injury to the chest as well as the abodmen, or the chest alone. Once immediate resuscitation is established to counter circulatory and respiratory collapse, a thorough careful examination is undertaken, including the central nervous system. A haemothorax or pneumothorax or a spinal injury may present with a rigid abdomen. In the absence of clinical and radiological evidence of chest injury, a persistent hypotension is indicative of intra-abdominal catastrophe. A head injury does not result in hypotension; a chest injury responds rapidly to re-establishment of adequate ventilation; multiple skeletal injuries, even though accompanied by a considerable reduction in the circulating blood volume, respond readily to transfusion. This is just one important guiding line. A number of personal cases will be reported and commented on to illustrate the various problems that may arise in the diagnosis and management of complicated and uncomplicated upper abdominal injuries.

Case Histories

Case No. 1

J.P., 4 years of age, was admitted on May 5th, 1967, 4 days after falling over the
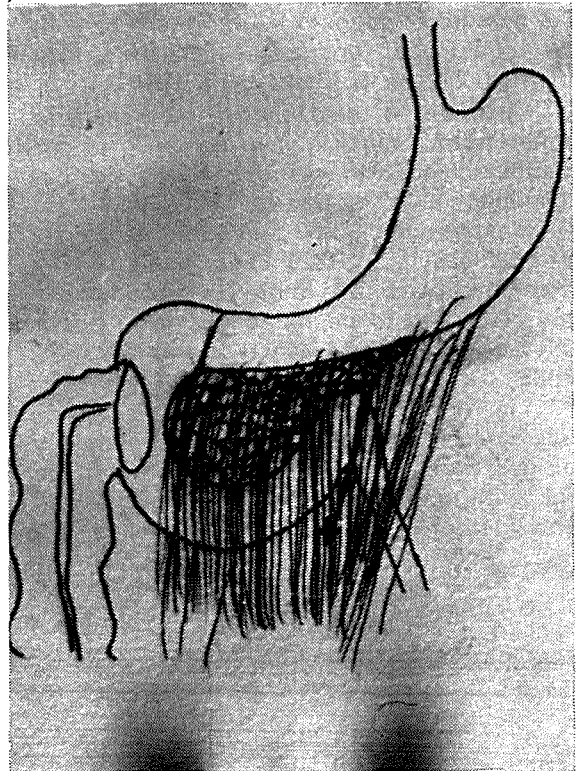

Fig. 1.

Case 1. Line marked X shows site of duodenal rupture at fourth part of duodenum.

handlebars of his toy tricycle. On admission he was shocked, B.P. 70 mm. Hg. systolic, pulse rate 130/minute, respiratory rate 38/minute. The abdomen was very distended by pneumoperitoneum and biliary peritonitis. After resuscitation a laparotomy was perfromed. The lesion was a circumferential tear at the duodeno-jejunal flexure (Fig. 1) with retraction of the proximal duodenum retroperitoneally. A two-layered suture was carried out. Five days later the child burst his abdomen. He was found to

have a peritonitis due to a dehiscence of the previous anastomosis. I resutured the bowel and the abdomen. The child made an uneventful recovery and was discharged home on the twelfth post-operative day.

Case No. 2

A.G., 35 years of age, was admitted on June 10th, 1967, unconscious and suffering from severe oligaemic shock; she had been the passenger in a car travelling at high speed down a hill. The car spun out of control and hit several cars on the way. The patient was wearing a loose-fitting diagonal safety belt (Fig. 2) over the left shoulder crossing the left ribs, right upper abdomen and tied to the centre part of the floor of the car. She was suffering from multiple injuries which included a fracture of the left clavicle, a fracture dislocation of the right shoulder (deceleration injury), multiple rib fractures on the left side of the chest, a minor left
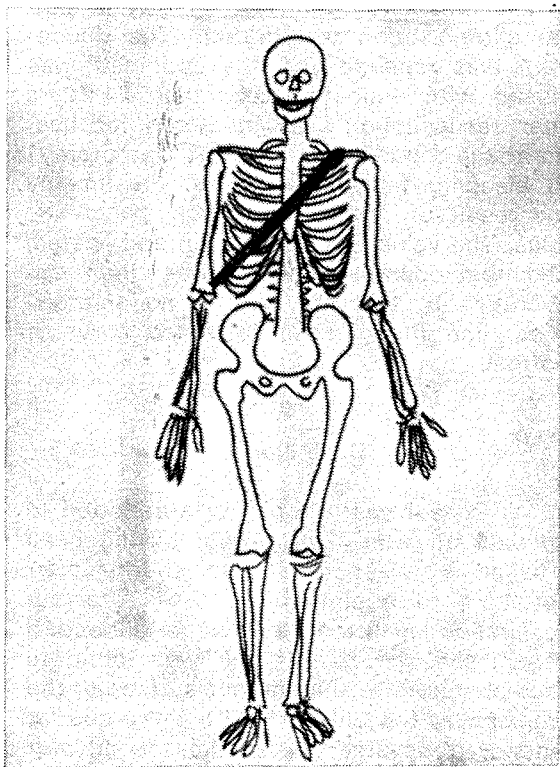

Fig. 2.

Case 2. The thick line across the chest shows the position of the ill-fitting diagonal belt.

haemothorax, a bruise on the skin overlying the right lower ribs and a rigid abdomen. Artificial ventilation by an endotracheal tube, drainage of the haemothorax, and a massive blood transfusion were instituted. The pulse became perceptible, a systolic B.P. of 60 mm.Hg. was recorded. In view of the lack of any further improvement, a laparotomy was carried out. A preoperative diagnosis of ruptured liver was made, conforming to the line of the injuries (Fig. 2). I found that the liver was almost completely split into two sections and partly avulsed from the inferior vena cava. The tear was deliberately completed on the avulsed portion. A central venous pressure apparatus had been set up prior to the operation. Packing the inferior vena cava did not stem the flow of ice cold blood from the rent. A cardiac arrest was treated successfully by cardiac massage, calcium and bicarbonate. The I.V.C. was then sutured and the hepatic vein reanastomosed. A further cardiac arrest proved irreversible.

Case No. 3

P.C., an 8 year old boy, was admitted on July 20th, 1967, the victim of a high speed motorway crash. He was dug out of the wreckage of a car. He was unconscious, pale with cyanosed lips. The abdomen was covered with vomit; there was considerable mucus in the throat, rhonchi and poor air entry in the right lung. B.P. gave a recording of 70 mm. Hg. systolic pressure. Pulse rate was 130/minute. He was restless; the left pupil was dilated, but both pupils were reactive. There appeared to be a VIII c.n. palsy. Tone in the four limbs was increased, and there was bilateral ankle clonus. Despite a blood transfusion, the B.P. remained at 70 mm. The left clavicle was fractured, so was the 5th rib on the right side. Despite large haematomas, there was no fracture of the spine or pelvis. The abdomen was rigid.

At laparotomy there was a considerable intraperitoneal haemorrhage, bruising of the left splenic pedicle with a partial tear of the splenic artery, a haematoma of the transverse meso-colon, a ragged four inch superficial tear on the diaphragmatic surface of the right lobe of the liver, a two inch linear tear nearer the anterior edge, and a tear on the

quadrate lobe just above the hilum. A splenectomy was performed, the tears on the liver were repaired by haemostatic interrupted sutures. A bronchoscopy was performed to clear the bronchus of inhaled blood from a tear on the tongue which was sutured. Next day the level of consciousness deteriorated and the tone in the left arm and leg was reduced. Forty-eight hours later, with improvement of consciousness, the endotracheal tube was removed. Respiratory distress and tracheal tug necessitated tracheostomy. Bronchopneumonia developed in the right lower lobe and frequent suction of tenacious mucus from the tracheostomy tube was essential. The long period of depressed consciousness was followed by considerable restlessness, requiring heavy sedation. It was thought the cerebral anoxia had played a considerable part in this process. He eventually recovered with residual weakness on the left side of his body which improved considerably with physiotherapy. In Germany, his mother's home, $2\frac{1}{2}$ months after the original injury, he was readmitted to hospital with fluctuating high temperature,, anorexia, dyspoena, increasing abdominal pains, reddish discolouration of the skin and a fluctuating turmour in the upper right abdomen. The leucocyte count was 18,000. Thirty ml. of pus were drained. A sinogram revealed a network of fistulae leading deep into the subphrenic space. There was also a right sided pleural effusion. A large subphrenic abscess cavity was twice revised and pus and necrotic tissue removed. The cavities were treated by suction and rinsing with neomycin and bacitracin solution, assisted by intravenous administration of Gentamycin. This child left hospital on March 6th, 1968.

Case No. 4

G.S., 6 years of age, was admitted on July 16th, 1968, having fallen over the handlebars of his tricycle the day before. He had vomited repeatedly and complained of abdominal pain 4 hours after the accident. On admission, he had bilateral shoulder pain as well as intermittent central abdominal pain. The pulse rate was 96/minute, B.P. 110/70 mm. Hg. The findings at laparotomy consisted of an enormous haematoma of the transverse mesocolon and sigmoid mesocolon, a haematoma at the root of the mesentery and a traumatic pancreatitis with gross fat necrosis. The colon was viable; haemostasis was assured and the lesser sac drained. Twenty-four hours later, there was a well established external pancreatic fistula; the skin of the abdominal wall was ulcerating very rapidly. At operation I exposed the lesser sac by removing the whole of the necrotic omentum. I found that the pancreas was in two parts, the neck having been crushed against the vertebral column. I removed the body and tail of the pancreas and the spleen, taking good care to preserve the superior mesenteric vessels, the middle colic vessels and inferior mesenteric vein. The duct of the head of the pancreas was not seen. 1012 U. of secretin were injected intravenously with no observable result. The duodenum was then opened, a sphincterotomy carried out between 000 silk sutures and a pancreatogram (Fig. 3) carried out. No extravasation was noted. The duodenum was repaired and the abdomen was closed with drainage. Less than 24 hours later resuscitation was instituted for haemorrhage found to be due, (at laparotomy) to bleeding from small veins, presumably the result of digestion by free pancreatic juice. The veins were picked up and ligated. The post operative course was then uneventful. To this day, ther is no steatorrhoea, and the glucose tolerance curve is normal.

Case No. 5

T.D., a 4 year old girl, was admitted to hospital on April 20th, 1969, having been crushed between two cars shortly after partaking of a sumptuous tea. After resuscitation laparotomy was undertakne for a generalised peritonitis. She was found to have a rupture of the anterior surface of the stomach at the antrum and a three quarter anterior transverse tear of the second part of the duodenum, the ampulla presenting at the tear (Fig. 4). A two layered repair of stomach and duodenum was carried out. The child was discharged home on the twelfth post-operative day.

Fig. 3.

Case 4. Operative pancreatogram showing probe inside the common bile duct, a polythene tube into the pancreatic duct which is outlined by radio-opaque dye.

Case No. 6

B.B. was admitted on 11.6.69 with a steering wheel injury to his chest and abdomen. His lips and the anterior chest wall were bruised. Chest X-ray showed a fracture of the 9th right rib. Plain radiograph of the abdomen was normal. Systolic B.P. was 90 mm. Hg., serum amylase 400 somogyi units. The blood pressure improved rapid-ly. I first saw him thirteen hours later. He now developed right shoulder pain; there was vague generalised abdominal tenderness and guarding. At laparotomy I found severe intraperitoneal bleeding. The falciform ligament was torn; there was a large rent in the greater omentum, the gall bladder was torn from its liver bed, the head and neck of the pancreas were shattered exposing the entire length of the portal vein.
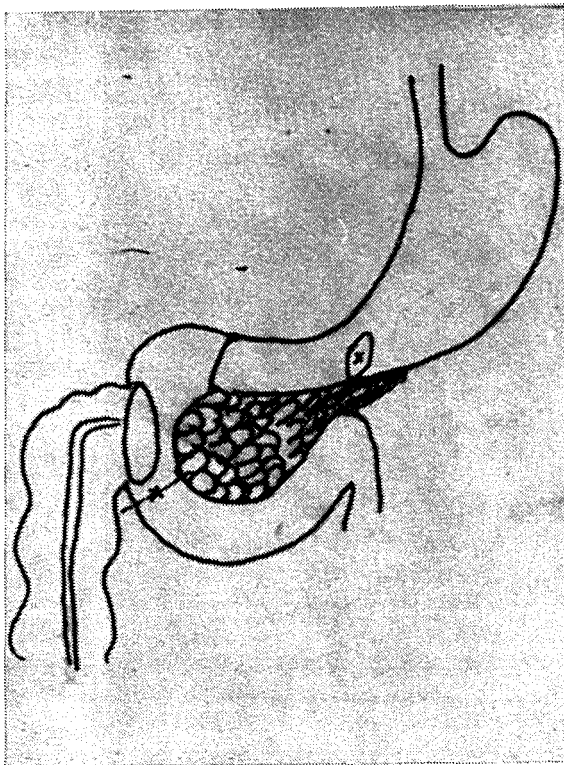
Fige. 4.

Case 5. X marks show the sites of stomach and duodenal rupture.

A Whipple pancreatoduodenectomy was performed with great difficulty due to haemorrhage and the normal calibre of pancreatic and common bile ducts. The size of the jejunal lumen having been reduced, an end to end choledochojejunostomy was performed. Below this the body of the pancreas was anastomosed by sero muscular sutures end to side to jejunum, a polythene catheter splinting the opening of the pancreatic duct. Below this the cut end of the stomach was joined end to side to the same jejunal limb. A cholecystostomy and a subhepatic drain concluded the operation. Accurate and copious blood replacement was maintained throughout.

Post-operatively he developed respiratory difficulties and bilateral basal consolidation. On the 7th day cholecystostomy stopped draining and a copious discharge of bile with a high amylase content (100,000 units) appeared from the sub-hepatic drain.

Suction was applied; the skin was treated with Eurcerin cream and Complan; ulceration was thereby prevented. Accurate fluid and electrolyte balance was achieved by parenteral fluids; parenteral feeding was also instituted. On the 24th June a feeding jejunostomy was necessary. A week later, the discharge had diminished considerably and the jejunostomy itself was discharging bile. The jejunostomy was therefore closed intraperitoneally. A persistent pyrexia was now shown to be due to an abscess in the right iliac fossa which was drained.

A rapid recovery ensued and the patient was discharged on 26th July. His abdomen is now soft and healed. He eats well and is gaining weight. Glucose tolerance is normal. His stools are soft with a 24 hour fat content of 5.1 gm. He has been given Pancrex V.2 capsules to sprinkle on his food and advised to maintain a high intake of fruit juices to combat a moderate hypokalaemia.

Discussion and Review of Literature
Duodenum

Mechanism of rupture. Following an impact to the right upper quadrant, the liver, protected by the rib cage, is displaced upwards with resultant traction by the hepato duodenal ligament and common bile duct on the stable pancreatoduodenal region. This produces an injury to the duodenum distal to the ampulla of Vater (Hauman, 1967). The retroperitoneal duodenum, closed proximally by the pylorus and distally by the acute angulation at the ligament of Treitz, is disrupted by the extrinsic pressure acting on the duodenal loop. The fourth part of the duodenum may be ruptured by compression against the vertebral column. Blunt abdominal trauma may result in an intramural haematoma. A rupture of the duodenum is nearly always single, more usually transverse. It rarely involves the whole circumference of the duodenum, as it did with Case I. (Estes, 1952; Hansen 1957; Pirkle, 1953). It is possible than in this case, the rupture may have been rendered complete several hours after the injury as a result of necrosis of the partially ruptured duodenum. How else can one explain the four day delay? Circumferential tears may require the adoption of a wide variety of surgical techniques. Laceration in

the region of the ampulla of Vater may, because of distortion of the anatomy by oedema and haemorrhage, require transposition of the common bile duct and pancreatic duct, unlike the easy repair that was carried out in Case 5.

Diagnosis

The diagnosis may be rendered difficult if the rupture is retroperitoneal. An intraperitoneal rupture results in generalised peritonitis. A retroperitoneal tear produces an accumulation of bile or blood or retroperitoneal air, visible radiologically, or demonstrated at operation by opening the lesser sac. This second type of injury may, by its very nature, be diagnosed late, twenty-four hours or even later following the injury. In a mixed type of injury as in Case 1, the extent of the serosal tear does not coincide with that of the duodenum. Peritoneal signs also occur later. Initially, there are few symptoms; a few hours later, the patient complains of pain in the flank or back, in the abdomen or thorax; the pains may be referred to the testicle (Butler, 1931). There is nausea, vomiting; the leucocyte count is slightly elevated. A plain radiograph may show air outlining the kidneys or the right crus of the diaphragm, air along the psoas muscle, subcutaneous air in the right flank or intraperitoneal air. At laparotomy, air may be found in the transverse mesocolon or mesentery; the diagnosis can be established by the presence of soap deposits, bile staining, haemorrhage and of course, the finding of a tear. An accurate two-layered suture and drainage are the standard treatment. A complete disruption of the ampullary region may render necessary the isolation of the common bile duct and pancreatic duct and their re-implantation. A wide variety of surgical procedures short of a Whipple resection can be carried out. An extensive resection in a very shocked patient may prove lethal.

Pancreas

Pancreatic injury by blunt trauma is frequently found in association with other injuries, such as a laceration of the liver and spleen (Sturim, 1966; Thal, 1964). The converse is not necessarily true. In a laparotomy for intraperitoneal haemorrhage, the pancreas must be included in the general examination. A pure pancreatic injury may be accompanied by severe haemorrhage and oligaemic shock, a major cause of death. In a large collected series (Wilson et al, 1967), haemorrhage accounted for 56% of deaths, and renal failure for 13%. The treatment of shock takes into account the central venous pressure response as a guide to volume replacement (Wilson et al, 1965). An accurate determination of the plasma volume can be carried out using radioactive iodine as a tracer. In a case not associated with severe haemorrhage, as in my fourth patient, an early diagnosis is equally important, because a delay of 24 hours or more is asociated with a very high mortality. Hence the importance of awareness of the possibility of pancreatic injury. The most consistent abdominal sign is tenderness with ileus and mild peritoneal irritation. Abdominal pain is usually present with no definite localisation. Restlessness and tachycardia are accompanying signs. With minimal bleeding, the major damage is from discharge of pancreatic secretions. Occasionally, a smaller leak will remain encapsulated and later present as a pancreatic pseudocyst (Di Censo et al. 1964). A serum amylase estimation on admission is a guide to the diagnosis. A high amylase count of the fluid released by abdominal paracentesis is an indication for laparotomy (Fogelman, 1961). As for the management of pancreatic injury, Walters et al. (1966), suggested that if injury to other organs could be ruled out, the standard conservative therapy for non traumatic pancreatitis should be carried out. Trasylol, a trypsin Kallikrein inhibitor, may reduce local damage and will retard the formation of vasoactive substances from inactive precursors. It has to be given in massive doses in the initial stages. Othersen et al (1968) maintain that children who have sustained a pancreatic injury may also have sereve associated injuries, in which case, an unnecessary laparotomy should be avoided, and some time ought to be spent on radiological investigation, including plain radiography of the abdomen to detect the presence of air, intravenous pyelography, upper gastro-intestinal radiography with absorbable contrast media (Thompson et al. 1966).

On the other hand, Cleveland et al (1963) maintain, like the present author, that a conservative approach to pancreatitis had solved few problems and has led to disappointment and disaster. Although at operation, a mildly contused pancreas ought to be disturbed as little as possible, it is wise to realise that the size of a haematoma is not related ot the extent of underlying pancreatic damage. According to various authors, (Estes et al. 1952, Mathewson et al, 1952) definitive surgery is limited to evacuation of the haematoma, control of haemorrhage and adequate drainage. The importance of adequate drainage is further emphasised by Cohn et al (1952) and Giordanengo (1967). With leakage of pancreatic juice into the peritoneal and retroperitoneal spaces, lack of drainage is associated with 100% mortality. But the complications of abscess formation, duodenal fistula, bile peritonitis and secondary haemorrhage have led to more aggressive measures than simple drainage. Doubilet et al (1951) advocate sphincterotomy and catheter drainage with primary repair of the pancreatic duct. Blandy et al (1959) utilised more extensive resections. Letton (1959), Freeark et al (1965), and Sturim (1966) treated transection of the pancreas by closing the distal side of the head, using a Roux-en-Y loop of jejunum to drain the distal neck. Kerry and Glas (1962) treat damage to the head by pancreatoduodenectomy, a proceduce which they maintain gives better survival than drainage of the area and repair of the duodenum. Martin and Henderson (1968) reported two cases of disruption of the head of the pancreas by blunt trauma in children treated by using a polyethylene tube as a splint round which the pancreatic duct was repaired with fine silk suture; the catheter was then passed trans-duodenally, retroperitoneally, and through the abdominal wall; a procedure also advocated by Doubilet and Mulholland. This is not possible with fragmentation of the pancreas, as in Case 4, or if the tail is transected and the spleen is ruptured. If the damage is limited to the tail of the pancreas, the proper form of treatment is resection of this portion. It is worth remembering that the duct of Wirsung offers most resistance to trauma (Giordanengo,

1967). If it is intact, no further treatment apart from control of haemorrhage is essential; if not intact, the tail of the pancreas can be removed. Tying both ends of the duct does not stop activity in the distal part of the pancreas with resulting necrosis, sloughing, fistulae, etc. A late pancreatic pseudocyst can be treated by various operative procedures, the easiest one being cystogastrostomy, (Attard, 1969).

Liver

Recent reports indicate that the liver is the most common site for a closed abdominal injury nowadays in the age of high speed automobile crashes (Balasegaram 1969, Baker et al. 1966). This is a debateable point. Yet again, it is well to remember that it is quite common for these patients to have associated injuries to the abdomen, chest and skull, as in Cases 2 and 3 under discussion. What renders the diagnosis more difficult is the range of injuries to the liver, starting from a sub-capsular haematoma, progressing to single or multiple linear or ragged tears to an almost complete dehiscence of the liver with avulsion of the hepatic viens from the inferior vena cava, a type of injury resulting from a compression of the rib cage towards the posterior abdominal wall followed by recoil. Awareness of the possibility of liver injury is important. In Case 2, apart from severe shock, the distribution of the other injuries in the line of the ill-fitting strap left little doubt as to the diagnosis. A useful aid is paracentesis which revealed a 95.4% accuracy in a series of 259 consecutive patients. (McClelland et al 1965). Balser et al (1966) reported 37.8% false negatives in adults, 60% false negatives in children. A more sophisticated test is the use of colloidal Au^{198} scanning of the liver and spleen in upper abdominal trauma to determine the outline, size, position of functioning liver and spleen. Post-operatively, a scan indicates the viability of the segments treated by suture haemostasis (Little et al 1965). Operative management varies with the type of injury.

In the presence of a subcapslar haematoma, one injects methylene blue into the common hepatic duct; if it extravasates rapture is diagnosed. Resection is the cor-

rect course to follow. Baker (1965) suggests an operative cholangiogram through the gall bladder or common bile duct. A linear superficial tear can be treated by haemostatic suture. A ragged tear requires excision of the devitalised edges and suture or packing. The complications following packing are many and may be lethal; they include secondary haemorrhage, biliary peritonitis, multiple abscesses, subphrenic abscess, haemobilia. It is therefore considered safer to excise the extensively damaged lobe along anatomical lines. The main divisions of the structures at the porta hepatis can be tackled first or else they can be tied off as the dissection through the liver proceeds, and they present into the operative field. The latter course can be accompanied by considerable haemorrhage. The complications following packing occur to a much lesser extent after a properly conducted resection. Possible pulmonary complications are pneumonitis, pleural effusion.

Conclusion

Six cases of severe upper abdominal injury have been reported. Their immediate and subsequent management has been discussed. It is obvious from the case histories and a review of the relevant literature that awareness of the various possibilities is the first prerequisite for a proper assessment and treatment of the patient. One must also beware of the presence of associated injuries which may be masked by the severity of trauma to one or other viscus.

Acknowledgments

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