Review Article

The management of liver trauma

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Summary: Despite advances in the management of liver trauma during the past 40 years, haemorrhage has remained the commonest cause of death. This article outlines the diversity of opinion between the desire to determine the extent of damage and resect devitalised tissue with its attendant risk of exacerbating haemorrhage, and the alternative of a more conservative approach.

Introduction

The incidence of both blunt and penetrating abdominal injury is steadily increasing, and the liver is one of the organs most commonly involved. Decelerating injuries cause the liver to tort on its peritoneal attachments often resulting in linear lacerations, whilst crushing injuries to the right hypochondrium may inflict deep fissured lacerations (Walt, 1974). Occasionally, sudden compression and expansion ruptures the parenchyma whilst the capsule remains intact. Although some 50% of liver injuries are minor and require no active treatment (Lucas & Ledgerwood, 1976), extensive injuries continue to be a major challenge to surgical skill. Associated trauma to the hepatic veins or inferior vena cava is particularly grave, and these problems are compounded by the presence of injuries to other organs in 90% of cases (Walt, 1974). Mortality relates not only to the extent of hepatic injury, but directly to the number of other organs involved (Levin *et al.*, 1978).

Management has turned almost full circle in the past 40 years; conservative measures adopted during World War II were associated with a poor prognosis (Madding *et al.*, 1945) and led to the adoption of more radical methods (Foster *et al.*, 1968; Ackroyd *et al.*, 1969). However during this time haemorrhage remained the commonest cause of death (Mays, 1976), and attention subsequently returned to more conservative measures (Levin *et al.*, 1978; Walt, 1978).

Assessment and resuscitation

The patient with exsanguinating intra-abdominal haemorrhage or a penetrating wound is rarely a diagnostic problem, but some 30% of patients with liver injury are normotensive on admission with minimal abdominal signs, only to deteriorate sometime over the following twelve hours (Walt, 1974). In addition to peritonism and an increasing abdominal girth, right lower rib fractures, clothing pattern marks on the abdomen, or Kehr's sign (right upper quadrant and shoulder tip pain) should raise suspicion of a liver injury. However, the severity of insult is not a good guide to the extent of trauma (Walt, 1980). Assessment may be difficult, particularly where there is an associated head injury, and it should be remembered that hypotension is rarely due to head injury alone. Chest and abdominal X-rays, although essential, are seldom diagnostic, but abdominal paracentesis is particularly useful in doubtful cases.

Good resuscitation is of the utmost importance in determining morbidity and mortality after trauma. A well stocked bloodbank and an experienced anaesthetist are essential, and concomitant injuries to other structures should not be overlooked. Respiratory distress syndrome and coagulopathy are common in patients receiving massive transfusions, and blood warmers and filters should therefore be used early, together with fresh frozen plasma and platelets, where appropriate, to compensate for washout coagulopathy (Clagett & Olsen, 1978).

If a patient with suspected liver injury is stable and

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abdominal girth is not increasing, management is conservative, but close observation for signs of deterioration is necessary. Further investigation in the form of ultrasound, liver-spleen scan or computerised tomography may be appropriate in some instances (Athey & Rahman, 1982; Evans *et al.*, 1976; Lutzker & Chun, 1981).

Evidence of continuing bleeding will require laparotomy, and wherever possible this should be delayed until the haemodynamic state is stable. Bleeding into the closed abdomen tamponades the source in most cases thus allowing some resuscitation, whereas early surgery may prolong the period of hypotension with irretrievable consequences. Early surgery in hypotensive patients significantly increases mortality (Neely, 1977).

Surgical management

Because haemorrhage is the commonest cause of early death following liver trauma, and extensive surgical procedures carry the highest mortality, it is suggested that the objective in the first instance should be to do the minimum to control the bleeding. This will allow a further period of resuscitation before definitive treatment is undertaken as a semi-elective procedure (Calne *et al.*, 1979). This however is only appropriate where some form of adequate haemostasis has been achieved in the first instance.

The line of treatment followed will depend upon the extent of damage, but there is no single accepted classification (Table I).

Grades I & II

The majority of these are not actively bleeding at the time of surgery, and no further action is necessary. When suturing is required, deep, tight sutures should be avoided in preference to precise placement in order to avoid devitalizing tissue and encouraging secondary sepsis. Most surgeons drain these injuries, although this has been criticized as both unnecessary and predisposing to retrograde infection (Fischer *et al.*, 1978).

Table I Classification of liver injury

Grade I	- Capsular tear with no parenchymal damage
Grade II	- Parenchymal damage responding to simple haemostatic measures
Grade III	- Parenchymal damage with major arterial or venous haemorrhage
Grade IV	- Extensive parenchymal damage associated with injury to major hepatic veins or retrohepatic inferior vena cava

Grade III

Initial control of haemorrhage may be achieved by temporary packing and occlusion of the porta hepatis by the Pringle manoeuvre (Pringle, 1908). A warm ischaemic time of up to an hour is considered acceptable (Huguet *et al.*, 1978). Visualisation of the source of bleeding may be difficult if the dome of the liver is involved, and failure to achieve control by the Pringle manoeuvre indicates the possibility of major venous injury. Having gained control, definitive steps may be taken for more permanent haemostasis, but it is here that opinion is diverse, and any decision must take into account the state of the patient and the experience of the surgeon. There are several options:

(1) Basic surgical principles favour debridement of non-viable tissue, local haemostasis by suture ligation, followed by closure of deadspace either by deep sutures or the use of a viable omental pack (Stone & Lamb, 1975; Pachter *et al.*, 1983). However the risk is of provoking further haemorrhage, and some reports suggest that lack of debridement does not significantly increase morbidity (Lucas, 1976).

(2) Local control can often be achieved by deep sutures and closure over collagen buttons. It too has been criticised on the grounds of leaving a closed deadspace and thereby predisposing to haematoma formation, secondary haemorrhage, or liver abscess (Olsen, 1982). In practice this is uncommon (Mays, 1976).

(3) Selective ligation of the hepatic artery may be required in addition to the above, providing that trial occlusion has been successful (Aaron *et al.*, 1975). It should be remembered that anomalous origin of either hepatic artery is not uncommon. Although doing nothing to control bleeding from retrograde flow in hepatic veins, venous haemorrhage may often be subsequently controlled by tamponade (Mays *et al.*, 1979), and this procedure has been widely used with good results (Foster *et al.*, 1968; Flint *et al.*, 1977). Rearterialization of the liver occurs rapidly via collaterals (Mays & Wheeler, 1974; Koehler *et al.*, 1975), and hepatic necrosis is extremely rare (Lucas & Ledgerwood, 1978; Flint & Polk, 1979).

(4) Packing, although widely criticized in the past (Madding *et al.*, 1945), can be a life-saving procedure (Feliciano *et al.*, 1981; Svoboda *et al.*, 1982). If the above measures have failed to control haemorrhage, lobectomy is the only thing likely to save the patient, but even in the best of hands carries a 50% mortality (Trunkey *et al.*, 1974; Walt, 1978). This figure may be considerably higher when performed on the critically ill patient by an inexperienced surgeon. Packing the injury for a period of 48–72 hours not only allows for a period of stabilization, but also transfer to a specialized unit if required. Often the packs can be removed without the need for further intervention, but facilities must be at hand to proceed to major resection

(Calne *et al.*, 1982). Packing is not appropriate for transferring a patient if the bleeding has not been controlled. The patient is likely to exsanguinate before lobectomy can be achieved by an experienced surgeon elsewhere (Smajda *et al.*, 1982).

(5) Lobectomy. Whilst some centres advocate resection as the definitive early treatment of major liver injuries with impressive results (Balasegaram & Joishy, 1981), it is generally reserved by others for when more conservative methods have failed in view of the high mortality.

Grade IV

Injuries to major hepatic veins or the retrohepatic inferior vena cava are the most challenging of all because of their inaccessibility, and even in the best of hands mortality ranges from 50–80% (Turpin *et al.*, 1977; Walt, 1980). Tamponade is sometimes successful (Walt, 1978; Calne *et al.*, 1979), but usually some attempt at repair is needed. Temporary control may be gained by compressing the liver against the posterior abdominal wall, or dividing the coronary and right triangular ligaments and rotating the right lobe medially to compress the hepatic veins (Betha, 1977). This may allow time to open the chest through either a median sternotomy or right thoracotomy, and thus gain control of the inferior vena cava above and below the liver. Internal vena caval shunts are employed successfully by some (Trunkey *et al.*, 1974; Defore *et al.*, 1976), but have proven uniformly fatal in the hands of others (Lim *et al.*, 1976; Walt, 1978). Vascular isolation of the liver without shunting is the alternative (McMaster & Tolley, 1977), but hypotension is often a problem. In practice, by the time that the diagnosis has been made and exposure gained, the patient is *in extremis*.

Despite some reservations, all liver injuries should probably be drained (Lucas, 1976). Prophylactic drainage of the biliary tree as advocated by Merendino *et al.* (1963) has been abandoned (Lucas, 1970), and T-tube drainage reserved for cases of damage to the extra-hepatic biliary system. Systemic antibiotics should be given if packs are left *in situ* (Calne *et al.*, 1982), and are generally employed for all wounds (Amerson & Stone, 1970), although not all agree with their use (Vajrabukka *et al.*, 1975).

Post operative care and complications

In addition to general measures in the care of the injured, particular attention is needed to pulmonary and specific metabolic complications.

Adult respiratory distress syndrome is common after massive transfusion, and may be compounded by associated chest trauma or thoracotomy. Pulmonary complications are the most common problem, and

their onset may be delayed and insidious.

Hypoglycaemia, although rare, may be encountered after lobectomy, and such cases should have a 10% dextrose infusion (Stone *et al.*, 1969).

Coagulation defects were found in 50% of one series after major liver trauma (Clagett *et al.*, 1978), either associated with massive transfusion of stored blood, or deficiency of liver-produced clotting factors.

Hypoalbuminaemia and deranged liver function are almost universal after lobectomy or hepatic artery ligation, and usually return to near normal within two weeks. Albumin infusions are reported to have no significant effect (Vajrabukka *et al.*, 1975). Cholestatic jaundice is nearly always associated with sepsis (Lawrence & Dawson, 1982). Untreated, sepsis may precipitate hepatic failure (Flint, 1982); the presence of acidosis and hyponatraemia in the face of intrahepatic cholestasis being particularly ominous (Mays, 1974). It is therefore extremely important that sepsis should be identified and treated early.

Acute gastric erosions are particularly common after lobectomy or drainage of the biliary tree (Foster *et al.*, 1968). The triad of colic, jaundice and intestinal bleeding may indicate the rare complication of haemobilia (Vallidis & Papalexandris, 1975) and the diagnosis can be confirmed by arteriography (Schorn & Coln, 1977). Hepatic artery ligation, embolization and resection have all been employed successfully in the treatment of haemobilia (McGehee *et al.*, 1974; Walt, 1978).

Prognosis

The widely quoted overall mortality figure of 15% is of little value because it reflects not only the degree of liver injury, but also the way in which it was caused and the extent of other injuries. Patients with blunt abdominal trauma or gunshot wounds fare much worse than those with stab wounds (Levin *et al.*, 1978), and whereas isolated liver injuries of all types together have a 6% mortality, that figure rises to 70% where 5 or more other organs are involved (McInnis *et al.*, 1977). Associated enteric injuries in particular have a higher mortality and morbidity (Defore *et al.*, 1976).

Conclusion

Considerable flexibility in approach is needed in the management of liver trauma. Haemorrhage remains the commonest cause of death in these patients, and the surgeon with limited experience or resources may be well advised to achieve haemostasis as simply as possible and then seek help from others, rather than attempt extensive mobilisation and exploration at the expense of provoking further haemorrhage in an

already seriously ill patient. Packing to achieve haemostasis is a reasonable thing to do when followed by early transfer of the patient to a special centre. A trade off must be achieved between the control of bleeding and risk of later complications.

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