LIVER SURGERY

with operative color illustrations

Edited by
ROY Y. CALNE, F. R. S.
Professor of Surgery
Addenbrooke's Hospital
Cambridge

with the collaboration of
G. QUERCI DELLA ROVERE, M. D., F. R. C. S. (Ed.)
St. Margaret's Hospital
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PICCIN MEDICAL BOOKS

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Contributors

STIG BENGMARK, M.D., Ph. D. (Surg.)
Professor of Surgery
Department of Surgery
University of Lund
Lund, Sweden

SAUL BESUZIO, M.D.
Institute of Surgical Pathology
Department of Surgery
University of Padua, Verona branch
Verona, Italy

ROY Y. CALNE, F.R.S.
Professor of Surgery
University of Cambridge
Clinical School, Level 9
Addenbrooke's Hospital
Cambridge, England

JOHN L. DAWSON, M.S., F.R.C.S.
Consultant Surgeon
King's Health District (Teaching)
King's College Hospital
Denmark Hill
London, England

BEN EISEMAN, M.D.
Professor of Surgery
Department of Surgery
University of Colorado
Medical Center
Denver, Colorado, U.S.A.

PER E. FREDLUND, M.D.
Department of Surgery
University of Lund
Lund, Sweden

MORIO KASAI, M.D.
Professor of Surgery
2nd Department of Surgery
Tohoku University
School of Medicine
Sendai, Japan

PAUL A. KENNEDY, M.D., F.A.C.S.
Assistant Clinical Professor of Surgery
Stanford University School of Medicine
Palo Alto, California, U.S.A.

MICHAEL KNIGHT, M.S., F.R.C.S.
St. George's Hospital
St. James' Hospital
London, England

L. KOEP, M.D.
Department of Surgery
University of Colorado Medical Center
Denver, Colorado, U.S.A.

CHIEH LEE, M.D.
Department of Surgery
Division of General Surgery
Veterans General Hospital, VACRS
Sheh-Pai
Taipei, Taiwan, Republic of China

TIEN-YU LIN, M.D.
Professor of Surgery
Department of Surgery
National Taiwan University Hospital
Taipei, Taiwan, Republic of China

B.R.D. MACDOUGALL, M.R.C.P.
Liver Unit, King's College Hospital
and Medical School
Denmark Hill
London, England

GORDON F. MADDING, M.D., M.S. (Surgery), F.A.C.S.
Associate Clinical Professor of Surgery
University of California School of Medicine
Associate in Surgery
Stanford University School of Medicine
Stanford, California, U.S.A.

MICHELE NIGRO, M.D.
Department of Pathology
University of Padua, Verona branch
Verona, Italy

G.B. ONG, D.Sc. F.R.C.S.
Head of the Department of Surgery
University of Hong Kong
Queen Mary Hospital
Hong Kong

G. QUERCI della ROVERE, M.D., F.R.C.S. (Ed.)
St. Margaret's Hospital
Epping Essex U.K.
Formerly Institute of Surgical Pathology
Department of Surgery
University of Padua, Verona branch
Verona, Italy

FARROKH SAIDI, M.D., F.A.C.S., F.R.C.S.
Tehran, Iran

Lord SMITH of MARLOW
149, Harley Street
London, England

JOHN TERBLANCHE, Ch.M., F.R.C.S., F.C.S.
Professor and Head, Department of Surgery
University of Cape Town
and Groote Schuur Hospital
Co-Director, The South African Medical
Research Council
Liver Research Group
and Head Department of Surgery
Somerset Hospital
Cape Town, Republic of South Africa

TON THAT TUNG, M.D.
Member of the Academie of Chirurgie (Paris)
and of the Academy of Medical Sciences
of the U.S.S.R. (Moscow)
Surgical Clinic VIET-DUC HUU NGHI
Hanoi, Vietnam

WILLIAM J. WALL, M.D., F.R.C.S. (C)
Assistant Professor of Surgery
University Hospital
London, Ontario, Canada

CHUNG-CHIEH WEN, M.D.
Taipei, Taiwan, Republic of China

ROGER WILLIAMS, M.D.
Liver Unit
King's College Hospital
and Medical School
Denmark Hill
London, England

Introduction

The object of this book is to provide the reader with illustrated descriptions of operations on the liver, excluding surgery for portal hypertension. The individual chapters are written by experts with their own approaches to the operation in question, so the result is an anthology of liver surgery which is not comprehensive. Inevitably there is some repetition and difference of views expressed between the individual authors. The reader may also disagree with some of the points made. For instance, I feel there is a definite place for packing of liver trauma cases, particularly in patients being treated in peripheral hospitals, and very good results have occurred with this technique*. Certain operations are extremely important and get consistently good results, for instance the treatment of hydatid cysts. Others are rarely indicated, an example being middle hepatic lobectomy where the dangers in the hands of even an experienced surgeon and the poor chances of obtaining a curative result in most cases make the operation seldom indicated.

In the discussion of the treatment of de-arterialisation of liver tumours there is no mention of the new techniques of selective transvascular arterial embolization which may be useful and do not require an operation.

The volume ends with a description and classification of hepatic tumours.

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* **Calne R.Y., McMaster P. and Pentlow B.D.:** The treatment of major liver trauma by primary packing with transfer of the patient for definitive treatment. *Br. J. Surg., 66:* 338-339, 1979.

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G.F. Madding, M.D., M.S. (Surgery), F.A.C.S.
Associate Clinical Professor of Surgery, University of California School of Medicine,
Associate in Surgery, Stanford University School of Medicine, Stanford, California
P.A. Kennedy, M.D., F.A.C.S.
Assistant Clinical Professor of Surgery, Stanford University School of Medicine, Palo Alto, California

Trauma of the liver

The number of patients admitted to emergency hospital services continues to increase and most of these are males. One very major problem in abdominal trauma is the proper care of injuries of the liver and vena cava. Lack of familiarity with anatomy [1] and methods of hemostasis as well as the complexity of some injuries are frequently the reasons for the poor results often reported.

Surgical anatomy

A working knowledge of the prevailing intrahepatic, vascular and ductal arrangements as well as their anomalies is necessary in the care of liver injuries. Such knowledge may aid in conserving functioning liver tissue and, on occasion, will obviate complications associated with the care of liver trauma.

Intrahepatic arrangements

The liver is divided into two surgical lobes by a fissure extending from the gall-bladder fossa inferiorly to the fossa for the vena cava above, known as the "main boundary" fissure [3]. No surface markings indicate the location of the fissure but it is clearly demonstrated in Figs. 1 and 1a.

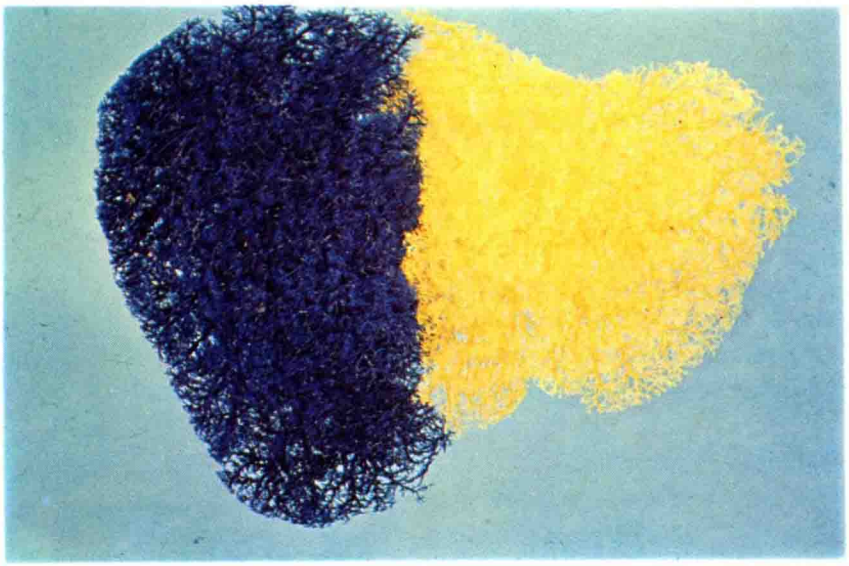

Fig. 1. Corrosion cast of the liver in which the right and left portal veins have been injected with different colored vinyl acetate. The main boundary fissure is clearly demonstrated. (Reproduced by permission of Dr. E. Truman Mays)

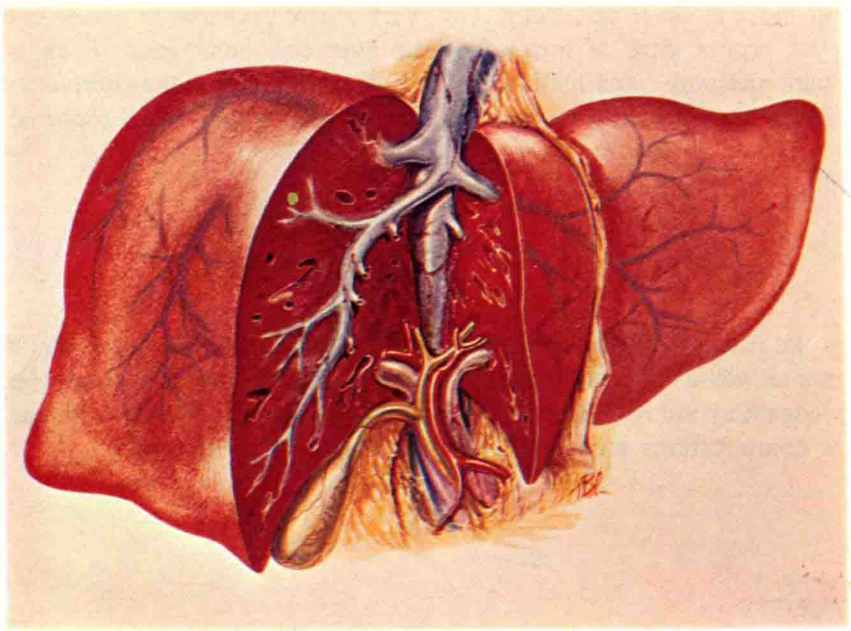

Fig. 1a. Artist's conception of a liver divided through the main boundary fissure starting at the gallbladder below to the vena cava above. The hilar structure, as well at the hepatic venous return, is clearly shown. The falciform ligament marks the segmental fissure of the left lobe. (Artist: Ted Bloodhart. Reproduced by permission of Dr. William P. Longmire, Jr.)

Corrosion casts in which the hepatic artery and the portal system have been injected clearly define this main boundary fissure between the right and left lobe as well as the fissure between the anterior and posterior segments of the right lobe (Fig. 2).

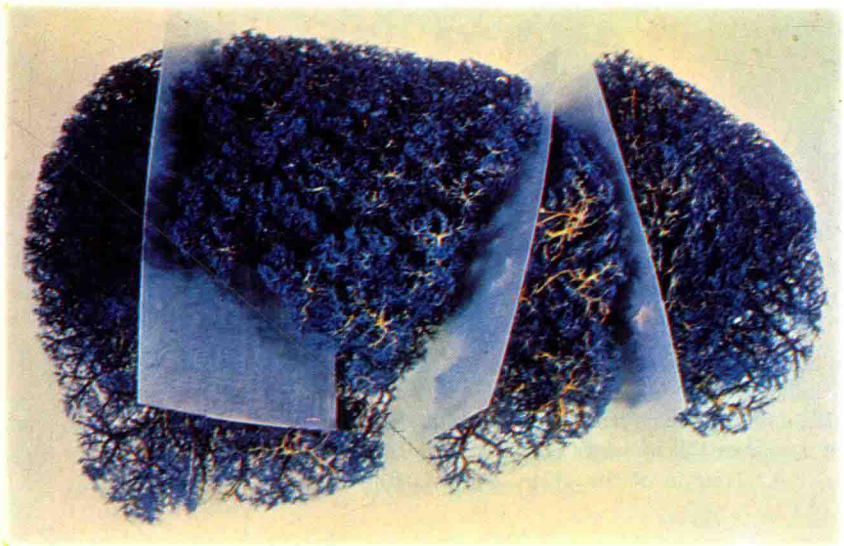

Fig. 2. Corrosion cast of the liver in which the portal vein, hepatic artery and biliary ducts have been injected. Dividers show the right lobe segmental fissure, the main boundary fissure and the left lobe segmental fissure. The left segmental fissure is incomplete.

Sub-segments can also be demonstrated by this technique. The left lobe is made up of two segments, a medial and a lateral, marked on the anterior surface of the liver by the falciform ligament. The falciform ligament is frequently used erroneously to designate the surface marking of the main boundary fissure.

Blood supply of the liver

The liver has a dual blood supply, the hepatic artery delivering 25 per cent and the portal vein 75 per cent of the inflow, each contributing about 50 per cent of the oxygen supply. The hepatic veins return the blood to the vena cava and do not follow the patterns of the portal veins and the hepatic arteries but cross almost perpendicular to them (Fig. 3).

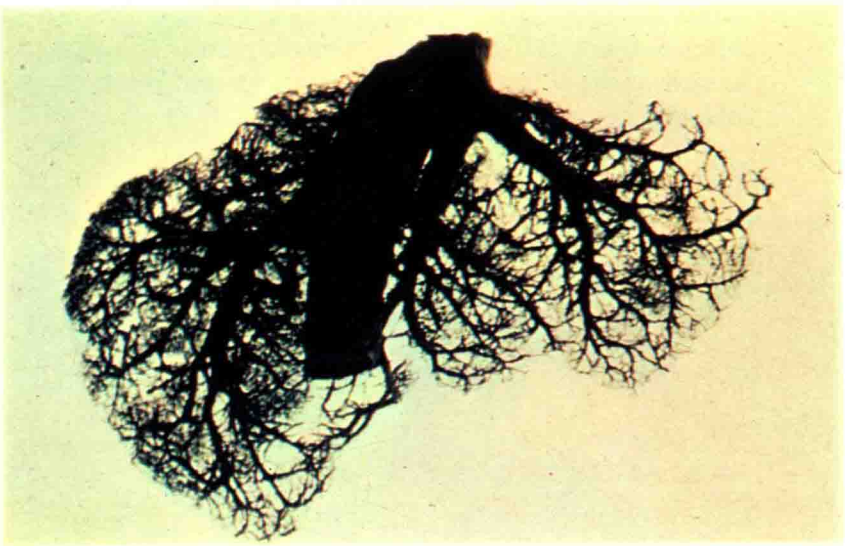

Fig. 3. Corrosion cast of the hepatic venous return. The middle hepatic and left hepatic veins join to make a common entrance into the vena cava. Branches of the middle hepatic veins cross the main boundary fissure to drain a part of the anterior segment of the right lobe. (Reproduced from Madding, G.F. and Kennedy, P.A.: Trauma of the Liver, 2nd ed., Philadelphia, W.B. Saunders Co., 1971.)

Fig. 4. An artery arising from the anterior segmental artery on the right joining a branch of the left hepatic artery. (Reproduced from Madding, G.F. and Kennedy, P.A.: Trauma to the liver, 2nd ed., Philadelphia, W.B. Saunders Co., 1971.)

Michels [15] found the usual textbook picture of the arterial supply to be present in 55 per cent of the dissections. In his series, the left gastric artery arose from the left hepatic artery in 25 per cent of cases. In half of these there was an additional left hepatic artery. Occasionally, the superior mesenteric artery gives rise to an additional right hepatic artery, in which instance it provides the entire blood supply to the right lobe. A knowledge of the possible anomalous arrangements of the arterial inflow is essential in the care of major liver wounds. This is particularly true when selective hepatic artery ligation is to be used for hemorrhage control.

It has been suggested that hepatic arteries are end arteries and without anastomosis in the liver substance. We have demonstrated anastomosis between the right and left lobes in corrosion casts (Fig. 4).

Michels [15] described 26 collateral arterial pathways to the liver. The studies of Bengmark, Rosengren [1] and others [11] have shown the importance of these collateral pathways following arterial inflow ligation. Posthepatic artery ligation studies in which the ligation was done for control of massive hemorrhage associated with trauma show collateral pathways suggested by Michels to be of considerable importance.

Extrahepatic artery distribution

The celiac axis gives rise to the common hepatic artery which runs through the hepatoduodenal ligament medial to the common duct and crosses over the portal vein. Usually the right hepatic artery enters the liver substance posterior to the hepatic duct. The left hepatic artery is shorter and immediately gives off its segmental branches. The artery terminates by division into medial and lateral left segmental branches. The right hepatic artery originates from the proper hepatic and passes behind the common duct, dividing promptly into an anterior and posterior segmental branch. Usually the right hepatic artery gives rise to the cystic artery. Michels [15] demonstrated a dual origin of the cystic artery in 25 per cent of dissections. The oblique course of the left hepatic artery permits an almost complete resection of the medial segment of the left lobe with preservation of the lateral segment [13]. In approximately 25 per cent of cases a major portion of the arterial supply to the left lobe comes from the right hepatic artery [2].

Portal vein

It has been said that the portal vein is the scaffolding upon which the liver is built. It begins and ends in a capillary bed and is formed by the juncture of the superior mesenteric veins and the splenic vein anterior to the vena cava and posterior to the pancreas. It measures approximately 8 cm in length and in the

porta hepatis runs posterior to the common bile duct and hepatic artery. The left branch of the portal vein is divided into a transverse portion in the hilum and an umbilical portion which runs in the segmental fissure between the medial and lateral segments of the left lobe of the liver. The right trunk of the portal vein is approximately 2-3 cm in lenght and runs laterally from its origin to the right, where it divides into anterior and posterior segmental branches. In two of our corrosion casts in which the portal system was injected the branch to the right anterior segment originated in the transverse trunk of the left portal vein. Although demonstrable anastomoses between branches of the portal vein are difficult to show, there is evidence of communication.

Hepatic veins

Corrosion casts of the hepatic venous system show that the two systems interdigitate in such a way that no lobar or segmental planes are demonstrable. The right hepatic vein drains the right anterior and right posterior segments of the right lobe and enters the vena cava in liver substance. The medial aspect of the anterior segment of the right lobe of the liver is drained partially by the middle branch of the hepatic vein, and thus crosses the main boundary fissure. The middle and left hepatic veins enter the vena cava usually as a single trunk. Anastomoses between hepatic veins have been reported but are difficult to demonstrate.

Biliary drainage

The pattern of the hepatic bile ducts follows closely the anatomical arrangements of the portal system [4]. It is difficult to demonstrate any communication between the right and left hepatic ductal systems. There is some evidence that the ducts do cross the left segmental fissure, however. The anterior and posterior segmental ducts on the right join to form the right hepatic duct. Healey [2] demonstrated that in 25 per cent of the dissections either the anterior or posterior segment duct of the right lobe crossed the lobar fissure to drain into the left hepatic duct. The right and left lobar ducts join in the transverse fissure to form the hepatic duct. There is a variation in the length of the duct, the average being 2.5 cm. The length of the cystic duct varies considerably. There is considerable variation in the length of the common bile duct as well; it is, however, consistent in its course and arrangement in the hepatoduodenal fold. Anomalies such as accessory bile ducts, a right or left hepatic duct entering directly into the gallbladder, a cystic duct joining the right hepatic duct and a right hepatic duct emptying into the cystic duct have all been demonstrated [16].

Improvement in mortality and morbidity figures related to liver injuries is usually attributable to better methods of resuscitating injured victims, more rapid transportation and greater knowledge of care of shock. In addition, the application of early exploration where intraabdominal injury is suspected and a more conservative approach to the definitive care of liver wounds restricting the use of large resections (lobectomies) and improved care of complications are all important.

Type and extent of liver injuries

The morbidity and mortality in patients with trauma to the liver depends in part on the mode of injury as well as the anatomic area involved. When penetrating wounds occur secondary to stabbing injuries, devitalization of hepatic tissue is frequently minimal and hemorrhage is usually not a significant problem unless a major vascular structure (hepatic artery or portal vein) has been penetrated.

While the number of penetrating wounds of the liver is increasing and still far outnumbers hepatic wounds produced by blunt trauma, the wounding agent in penetrating wounds is changing. The ice pick and stab blades are being replaced by hand guns of varying caliber. Thus, the nature of wounds produced by the penetrating agent more closely resembles blunt or bursting liver injuries seen in blunt trauma.

Preoperative evaluation

In penetrating wounds of the abdomen diagnosis of possible liver injury is not difficult. In such wounds it is important to determine whether the thorax may have been involved. For practical purposes it can be assumed that any perforating fragment that crosses the horizontal plane bounded by the plane of the costal margin and the 12th rib below, and a line between the nipple and angle of the scapula above, may perforate the diaphragm.

In a significant number of patients (over 25 per cent) admitted to the emergency department with blunt abdominal injuries, urgent laparotomy will be required, for hemorrhage is so life-threatening that laparotomy and control of bleeding is essential. Hemorrhage may occur faster than blood can be replaced. Under such conditions restoration of effective circulating blood volume cannot be obtained without first controlling hepatic hemorrhage. In such instances operation must accompany rather than follow restoration of blood volume.

Balanced salt solutions should be used to restore blood volume while whole blood for transfusion is typed and crossed marked. There is considerable evidence that crystalloids promote a better recovery for the critically injured patient than transfusion of large amounts of stored blood [11].

In the larger group of patients who are less critically ill, a longer period of time may be used to advantage for more studies. Repeated examinations by the same surgeon are of utmost importance. This approach is particularly important in evaluating findings in children from whom the history can be unobtainable and difficult to evaluate. Although it is well to limit the overall supervision to one person, consultations are in order.

Operative approach and surgical procedures

Incision

An upper midline or right paramedian incision is preferable. The lower thorax should be prepared in the event that it may be necessary to open the chest either by extending the incision into the right thoracic cage (7th, 8th, 9th intercostal spaces) or a median sternotomy.

Thoracoabdominal incisions are attended by a greater morbidity in the postoperative period. Additional exposure can be obtained for care of some lesions by dividing the ligamentum teres, after which the falciform ligament is incised to permit the surgeon to pass his hand over the dome of the liver and with gentle pressure deliver the liver into the operative field. After thoroughly evaluating the extent of the liver wound (whether it be peripheral, hilar, centre, a subcapsular hematoma, or deep bursting type lesion which may be hidden to gross inspection, or a hepatic venous injury) the surgeon should then formulate a plan for a successful approach to the problems presented.

After the abdomen has been opened and an assessment made, all detached liver fragments, blood, and blood clots should be removed. The most efficient method of accomplishing this is by using the cupped hand as a scoop or by using a moist lap sponge. The suction apparatus is inefficient in such cases, and potentially very dangerous. The overzealous use of the suction may extend the liver laceration or fracture.

Hemostasis for liver injuries

The techniques and materials used for control of bleeding from liver injuries will determine, to a large degree, the morbidity and mortality associated with this group of injuries. Control of such bleeding can be difficult. A thorough knowledge of the anatomy of this organ is most important particularly when some hemostatic methods are used; i.e.: vessel ligation and/or resections.

Frequently the large amount of blood seen in the peritoneal cavity of the patient with a liver injury is misinterpreted as evidence of a liver wound that is still actively bleeding [9]. Most experienced surgeons reporting on this subject have noted that in over 50 per cent of the cases there is no active bleeding when explored and adequate drainage will suffice as treatment.

The group that has persistent bleeding from the liver wound which is not controlled by compression (either manual or by temporary gauze packing) will require additional measures at the time of laparotomy. This bleeding can often be controlled by use of gauze packs over the site of injury and held in place

either manually or by placement of packs over the liver for dome injuries, where pressure is exerted by the overlying diaphragm. Ten to fifteen minutes of such compression will often result in cessation of the bleeding.

If bleeding persists after pack removal, hemostasis can usually be obtained by clipping or suture ligation of exposed individual vessels.

Bleeding from within the liver of a recalcitrant nature is usually arterial. Selective hepatic artery ligation [5, 6, 7, 10, 11] is an effective, simple and highly effective and safe means of controlling arterial bleeding which cannot be controlled by simpler methods described. Hepatic artery ligation was first suggested for use in acute liver trauma in 1954 [5]. It is now widely used.

We have demonstrated, as have others (Fig. 4), that hepatic arteries are not end arteries and that communications within the hepatic arterial tree do exist and function. These translobar and subcapsular collaterals are effective in reconstituting blood flow in an hepatic artery as soon as 24 hours after ligation [10, 11].

Superficial peripheral lacerations, usually the result of stab wounds or smaller calibre gunshot wounds, are treated simply by drainage or by simple suture if active bleeding exists, followed by drainage. In the absence of bleeding, no sutures or clips are used. Such treatment will be sufficient for the majority of liver wounds.

Deep lacerations are managed by ligation or clipping all bleeding points when accessible. Deep arterial bleeding can be determined by manually compressing the appropriate branch of the hepatic artery (Fig. 13). When the appropriate branch or branches of the hepatic artery have been determined, these may then be ligated. Such ligations are a simple and highly effective means of stopping such bleeding. Enlarging deep lacerations to provide better exposure of specific bleeding vessels can be used but is time consuming and frequently less effective than hepatic artery ligation. In all deep lacerations we avoid reconstructing the liver profile with sutures, for this is hazardous and often leads to intrahepatic accumulations, abscess formation and hemobilia.

From a technical standpoint, the most difficult wounds are those which are fragmented or inaccessible, rendering them difficult for suturing or clipping of bleeding vessels. It is in this group that *resectional debridement*, and on rare occasions sublobar resections, may be required.

Although we strongly condemn the use of gauze packs for anything more than temporary hemostasis, Stone and Lamb [17, 18] have recommended an autogenous omental pack as a method to control massive bleeding from the traumatized liver (Figs. 5, 6, 7). This method has been found useful by them in more than 100 cases and, in their experience, carries a 5 per cent mortality in a group that could have a predictable fatality rate of 30 per cent [17, 18].