Management of Liver Trauma in 259 Consecutive Patients *

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THE INCIDENCE of liver trauma is increasing each year. This is especially true regarding blunt trauma to the liver since more than 4,000,000 people in the United States are involved in automobile accidents each year. Many of these injuries are abdominal injuries and some 15 to 20 per cent of the abdominal injuries involve trauma to the liver. In view of the magnitude and importance of this problem, a series of liver injuries seen at Parkland Memorial Hospital over the period from January 1, 1953, to January 1, 1963, was reviewed.

During the period reviewed there were 259 injuries of all types which involved the liver alone or in combination with one or several other visceral organs. These injuries were inflicted by stabs, gunshot and shotgun missiles, as well as various kinds of blunt trauma. This series of injuries is a sequel to a series of 100 cases of liver trauma presented from this same hospital by Sparkman and Fogelman [27] covering the period from 1947 to 1953. Data will be presented to assess the results of some present-day concepts of the management of liver injuries in this institution.

Two hundred and fifty-nine patients were reviewed for the following aspects: age, sex, race, type of inflicting agent, anatomic nature of the injury, presence or absence of shock on admission, diagnosis, type of repair carried out, amounts of fluid and blood given, use of antibiotics, complications and mortality. This material was then correlated and, in some instances, comparisons drawn with comparable series of liver injuries in the literature.

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Results

Diagnosis after Blunt Trauma. A history of trauma to the abdomen, most frequently in an automobile accident (80.7% of the blunt trauma in this series), was extremely helpful. On physical examination the presence of abdominal spasm or rigidity was the most helpful sign. In addition to the history and physical examination of the patient, it was found that two other diagnostic adjuncts were useful—alterations in blood pressure and peritoneal tap. Many of these blunt trauma patients (64.5%) were in shock. It was found that a valuable sign of continuing intra-abdominal hemorrhage was that when the patient was given a rapid infusion of 500 to 1000 cc. of Ringer's lactate solution, the pressure would frequently rise quickly to approximately normal levels and then drop precipitously within a few minutes after the infusion was completed. Patients who were hypotensive from minimal blood loss would not have this fall in pressure after completion of the infusion. This volume of fluid generally was infused over a period of 20 or 25 minutes while other measures such as blood typing and cross-matching were being carried out. Postural hypotension, or drop in blood pressure on setting the patient up, was another useful sign of continuing intra-abdominal bleeding. Of course, both of the blood pressure signs were useful only in the case of doubtful or

possible injury and hemorrhage. It was not necessary to observe such signs in persons in deep shock and with obvious signs of severe intra-abdominal injury.

Abdominal paracentesis was performed in 22 of 31 instances of blunt injury. An 18-gauge spinal needle was introduced into one or more quadrants of the abdomen. With a single exception all taps yielded non-clotting blood, which was considered of diagnostic significance. This procedure yielded a diagnostic accuracy of 95.4 per cent.

Table 1 shows the incidence of these injuries according to the number of patients divided by sex and race and according to the type of traumatic agent. As will be noted, there was a good representation of blunt trauma cases (11.9%), the worst type of injury insofar as mortality rates are concerned.

Surgical Therapy. Table 2 indicates the various methods of treatment which have been carried out on these patients.

No suture repair was carried out in 75 (28.9%) of the cases. Most of the wounds were drained widely and were small, simple lacerations or perforations which had stopped bleeding. In the entire series, 93.1 per cent were drained and the drainage was usually carried out using several soft 1-inch Penrose drains placed next to the wound and in the subhepatic and subphrenic spaces, bringing them out either an adequate (two-finger breadth) stab wound near the wound in the liver, or through the abdominal incision—whichever lent itself to the shortest and most direct route of drainage. If the laceration was extensive and extended far posteriorly so that anterior drainage was inadequate because it was too long and circuitous a route, then drains were also brought out through a separate posterior stab wound near the tip of the twelfth rib, particularly in cases of blunt trauma or blast injuries with extensive damage to the liver. The drains were usually left in over a period of 7 to 10 days, being slowly removed over a 3 or 4-day period after drainage had essentially ceased. They were never removed in the presence of copious biliary drainage, or any biliary drainage at all, until a good tract had formed around the drains which was thought to be no sooner than 2 weeks.

For the usual laceration which was rather extensive and continued to bleed (55% continued some bleeding at the time of operation), it was found that the use of interlocking horizontal mattress sutures of 0 or 1 chromic catgut set back about 2 cm. from the edge of the laceration on each side was always adequate for controlling hemorrhage and bile leakage, and no re-explorations for rebleeding were necessary. The sutures were tied so that the edges of the lacerations were approximated but not tightly enough to cut through the liver. Sutures were usually taken with a long curved tapered needle, passing the suture as deeply as possible into the liver. It was

TABLE 1. *Incidence of Types of Injury*

No.	Race	Sex	Stab	Gun Shot Wound	Blunt
145	Negro	Male	72	65	8
54	White	Male	19	24	11
10	White	Female	0	3	7
2	L. Amer.	Female	1	1	0
28	Negro	Female	12	11	5
20	L. Amer.	Male	13	7	0
259			117	111	31

TABLE 2. *Methods of Treatment*

Method	%
No Suture	28.9
No Suture or Drains	4.5
Suture	71.1
Suture and no Drains	2.0
Gelfoam with no Suture	2.0
Gelfoam and Suture	5.2
Falciform and Suture	1.0
Gauze Pack	0.4
Resection (Lobar and Sublobar)	9.6

felt that this was not as traumatic as the blunt needle introduced by Kousnetzoff over 50 years ago.

In the entire series a gauze pack was used only once in 259 cases, and this occurred early in the series. More frequently in the later cases partial lobectomy or total lobectomy was used to handle cases of massive trauma, rather than resorting to packing. There were 25 resections, most of which were sublobar in extent, though seven were right total lobectomies and four were left total lobectomies. The average patient in this entire series received 1,569 cc. of blood during operation and 1,608 cc. of Ringer's lactate solution; 44.6 per cent did not receive any blood.

Complications. Nonfatal complications occurred in 53.3 per cent of the cases. There was an involvement of the thorax and intrathoracic organs in 38.4 per cent of the cases, so there was a high incidence of pulmonary complications with 17.4 per cent having atelectasis or pneumonitis, 7.7 per cent pleural effusion, and 0.5 per cent empyema. Bronchoscopy was required for persistent atelectasis in 1.5 per cent of the cases.

Some patients (6.8%) developed purulent intra-abdominal or intrathoracic collections which required subsequent drainage. It is noteworthy that 53 per cent of these purulent complications were associated with colon injuries, and 32 per cent of the colon injuries were associated with abscess formation of this type. There were four cul-de-sac abscesses, all associated with wounds of the colon. The one case each of mid-abdominal abscess and empyema were both associated with colon injuries. Of the nine subphrenic abscesses, however, only two were associated with concomitant colon injuries. This is readily explained by the usual intraperitoneal fecal soilage following colon injury. None of the 18 patients who developed the various purulent collections died. Of the 16 superficial wound infections only one was associated with colon injury, and the reason for this is felt to be that all superficial portions of all wounds associated with colon injuries were left open down to the fascia until the danger of infection passed and then were closed secondarily or were allowed to heal by third intention.

The incidence of prolonged biliary drainage was considerably lower than in the earlier Parkland series. In that group there were three transient external biliary fistulae, two instances of bile peritonitis and two of biliary effusion in 100 cases, whereas in the later group of 259 cases there was only one transient biliary fistula, no case of bile peritonitis and two cases of biliary effusion. All of these patients survived.

Three patients in this series developed fatal bleeding tendencies during the course of operation. They suffered extensive blood loss and in each case received in excess of 10 pints of blood. They usually began to ooze from all wounds and even uninjured peritoneal surfaces after receiving from 7 to 10 pints of blood. All received calcium, vitamin K, the freshest blood available, protamine and, in some instances, fibrinogen intravenously to no avail. This seems to be another reason for giving no more blood than is necessary to replace the blood loss to a point slightly below the amount the patient has lost.

Table 3 summarizes the percentage of various postoperative complications encountered.

Mortality. The overall mortality in this series was 11.2 per cent. One hundred and twenty-two patients in the present series had penetrating or perforating injury of the liver alone, with occurrence of only one death. Forty-seven per cent of all the patients were in shock with blood pressures below 80/40 when first seen in the emergency room. Of the 29 patients who died, all had pressures below 80/40 when first seen, and most had no recordable pressure when first seen. Fifteen (52%) of the pa-

tients who died did so of massive hemorrhage (usually associated with multiple injuries) before they were removed from the operating table. The causes of death in the 29 fatal cases are tabulated in Table 4.

The mortality in liver trauma is in direct relation to the number of other organs involved. Table 5 shows the rising percentage of mortality when organs in addition to the liver were injured. The highest mortality rate occurred when a major vessel (including the aorta and vena cava) was injured, with 77.8 per cent dying of these injuries. The next most fatal association was that of liver and colon injuries combined with a 48 per cent mortality. Most of the mortalities from the combination of liver and colon injuries in the series, however, occurred from massive blood loss in association with other multiple injuries and not from subsequent complications such as infection and abscess formation.

TABLE 3. *Postoperative Complications*

Type	%
Fever of Unknown Origin	8.2
Superficial Wound Infection	7.2
Atelectasis and Pneumonitis	17.4
Urinary Tract Infection	2.6
Prolonged Ileus	5.1
Subphrenic Abscess	4.6
Cul-de-Sac Abscess	2.0
Mid-Abdominal Abscess	0.5
Fecal Fistula	1.0
Intestinal Obstruction	2.6
Antibiotic Reaction	2.0
Pleural Effusion	7.7
Hemo-Pneumo-Thorax (Developing Post-op)	0.5
Necrotizing Fasciitis	0.5
Schizophrenia	0.5
Bronchoscopy Required—Persistent Atelectasis	1.5
Small Bowel Fistula	0.5
Jaundice	2.0
Empyema	0.5
Dehiscence	0.5
Renal Failure	1.0
Pulmonary Embolus	0.5
Biliary Pleural Effusion	1.0
Stress Ulcer	1.0
Biliary Fistula	0.5
Hemobilia	0.5
Hemopericardium	0.5
Bleeding Disturbance	1.5
Thrombophlebitis	1.0

TABLE 4. *Causes of Death*

Blood Loss	15
Hemo-Pneumo-Thorax	1
Myocardial Contusion	1
Congestive Atelectasis	4
Atelectasis and Pneumonia	1
Unrecognized Liver Injury—No Surgery	1
Brain Injury	2
Stress Ulcer	1
Bowel Infarction (Complete)	2
Renal Failure	2
Peritonitis	2
Total	29

The mortality from blunt trauma to the liver in this series was 25.8 per cent of 31 blunt injuries to the liver. (The average of several series is 67% according to Mikesky, Howard and De Bakey.[20]) When the blunt trauma involved only the liver the mortality rate was 13.3 per cent, whereas it climbed to 28.6 per cent when the spleen was also ruptured (as it was in 30.4% of the blunt trauma cases). When there were multiple blunt injuries to three or more visceral organs (as there were in 13.0%), the mortality rose to 66.7 per cent. Of the blunt trauma patients in this series 52.2 per cent had blood pressures below 80/40 when initially seen, and all who subsequently died had pressures below this level.

The mortality rate for the 25 patients who had resections for massive trauma to the liver was 20.0 per cent, which, in view of the extensive injury, was gratifying. There were a number of complications in the 25 cases of resection: four pleural effusions, two subphrenic abscesses, one subphrenic bile collection, one cul-de-sac abscess and one empyema, but none of these complications were fatal. The causes of death in the five resected patients who died were: one renal failure, one stress ulcer, and three who died during operation from massive hemorrhage and multiple trauma. One case of hemobilia in a child

TABLE 5. *Relationship of Associated Injuries to Mortality Rate*

	Injuries	Deaths	%
Liver Alone	138	2	1.0
Liver Plus One Injury	41	2	7.5
Liver Plus Two Injuries	32	4	12.5
Liver Plus Three Injuries	23	7	30.4
Liver Plus Four Injuries	8	4	50.0
Liver Plus Five or More Injuries	17	10	58.8
Total	259	29	11.3

was treated by resection with uncomplicated recovery.

Discussion

Diagnosis. Early diagnosis is extremely important in lowering the mortality from liver injuries, especially those caused by blunt trauma. Lawson [14] believes that the presence of abdominal rigidity alone warrants exploratory laparotomy in blunt abdominal trauma. Fitzgerald, Crawford and De Bakey [7] had no deaths in patients subjected to laparotomy without intra-abdominal injury being found, but three deaths occurred from intra-abdominal hemorrhage when exploration was not performed because the abdominal injury was masked by head injuries.

Many have recently reported favorably on their experience with diagnostic abdominal paracenteses as an aid in the early diagnosis of doubtful cases of blunt abdominal trauma. Rives [23] reported a large series of abdominal paracenteses from his recent study of blunt abdominal trauma at Charity Hospital in New Orleans with an accuracy rate of 94 per cent. Most reports previous to these, as indicated by Giacobine [8] and by Drapanas,[6] have noted an accuracy on performing diagnostic paracenteses of only 80 to 85 per cent. It must be emphasized that a negative tap means nothing! Close observation of the patient must continue with repeated taps at intervals if the index of suspicion is high. If the abdominal signs suggest intra-abdominal injury, exploration must be done immediately regardless of negative abdominal tap. Two of the 22 patients in this series with positive taps did not yield positive taps until several hours after injury, and both of these patients had no other signs warranting earlier exploration.

Generally the taps in this series were done on patients in whom there was doubt as to intra-abdominal injury or in patients obtunded by head or other injuries upon whom reliable abdominal examinations could not be carried out. It has been demonstrated that shock is rarely due to head injury unless the patient's condition is terminal from the head injury. Clark [4] has recently corroborated this in a study of head trauma done at Parkland Hospital. Abdominal tap has been used for diagnostic purposes for over 7 years at Parkland and on no occasion has there been any complication from its use. At times the bowel lumen has been entered but it has been shown that a 18-guage needle hole seals immediately with no significant leakage.

Surgical therapy. *Non-bleeding wounds.* The rationale for not suturing small non-bleeding wounds has been that it is perhaps better not to suture small holes tightly, thus creating in some instances dead spaces within the liver which could subsequently lead to abscess formation or hemobilia.[24, 27] It is also felt that to place sutures about a small, non-bleeding, slit-like laceration of the liver may lead to strangulation and necrosis of surrounding liver tissue which could lead to slough and infection of liver tissue far more serious than any slight rebleeding or drainage which might occur if the small wound were not sutured. In none of 78 patients did complications develop from not suturing the wounds, nor was there an instance of rebleeding, biliary fistula, peritonitis or excessive drainage of bile from the drain sites. Crosthwait and De Bakey [5] noted in their report on liver trauma that some of the wounds were also treated by a non-suture method with ade-

quate drains. They, too, reported no difficulty with this method of treatment.

Hemostatic Agents. Another departure from the usual therapy of liver wounds was less use of hemostatic agents such as Gelfoam and Oxycel. It was noted in the first series from Parkland and in some of the earlier cases of this series that Gelfoam was plugged into wounds which were clean and not bleeding. Also these agents have in the past been wedged into a laceration for hemostasis before suturing. Whitcomb [28] states that Gelfoam in a wound of the liver may wedge the liver apart and extend the laceration, causing more bleeding deep to the Gelfoam, and may trap potentially infected and necrotic tissue and blood deep within the liver. This may lead to secondary hemorrhage, bile drainage, abscess or hemobilia. Whitcomb also stresses that Gelfoam interferes with the anatomic approximation of the surfaces of the laceration and thus prevents early healing of the wound. In one case done early in this series a large piece of Gelfoam was thrust deep into a laceration, and this instance represents the only prolonged and copious case of bile drainage in the entire series, with drainage continuing heavily for 13 days from a simple, uncontused, linear laceration of the liver from a stab wound.

Biliary Drainage. None of the 18 patients who were not drained developed any ill effects; but as Sparkman and Fogelman [27] pointed out, generally the wounds which were not drained . . . "were those in which the least severe degrees of hepatic damage were encountered." It must be emphasized, however, that it is impossible to determine at the time of operation which wound is or is not likely to need drainage, regardless of how innocuous the wound may appear. All probably should be drained. De Bakey and Crosthwait [5] noted the occurrence of fatal bile peritonitis in two of their patients who were not drained. It must be stressed that before suturing lacerations where large branches of veins or the biliary tract are interrupted, ties with individual suture ligatures should be placed before closing the laceration with catgut mattress sutures. If the laceration is so large that there is potential dead space in its depths, then, as suggested by Krieg [12] and Sparkman and Fogelman,[27] a large Penrose drain should be placed in the depths of the liver wound before it is closed loosely about the drain. This prevents formation of hemorrhagic and purulent collections within the liver that may later lead to hemobilia and intrahepatic abscess.

Blunt Trauma. The most difficult liver wound to treat and the type producing the greatest mortality is a liver shattered by severe trauma. It is difficult or impossible to suture such complex injuries, and in the past it was the custom to insert quantities of gauze packing into the wound to attempt to control the bleeding. Frequently this did not control the hemorrhage, or if it did, fatal hemorrhage often recurred when the pack was removed. The pack was also harmful in that it led to pressure necrosis. Secretions, blood and bile could not drain through it, producing severe infections, intrahepatic and subphrenic abscesses, biliary fistulae and other complications.

Jaffe [11] reported a case of severe secondary hemorrhage following removal of a gauze pack from the liver as recently as 1956.

More frequent use of resections in handling severely traumatized livers has been recommended by Byrd and McAfee,[3] Longmire [16] and others. By resecting the injured lobe one obtains accurate control of the hemorrhage, removes the devitalized liver tissue and, therefore, reduces the probability of continued or recurring hemorrhage or the formation of abscesses and biliary fistulae. Langenbuch [13] performed the first partial lobectomy of the liver for neoplasm in 1887, but it has only been recently that the technics learned in resections for neoplasms have been applied in trauma.

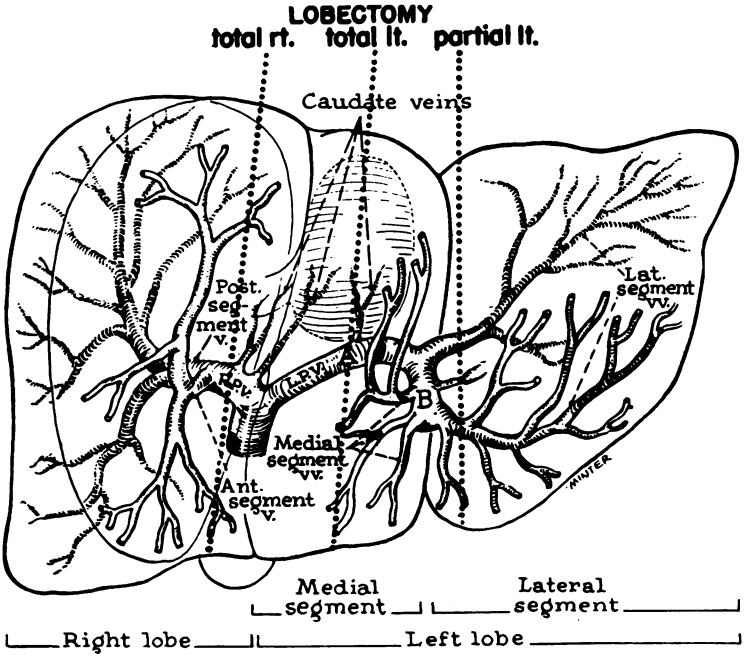

FIGURE 1

"After Healey, from Braasch, J. W.: The Surgical Anatomy of the Liver and Pancreas. Surg. Clin. N. Amer. (June) 1958."

We have generally followed the methods of resection cited by Quattlebaum.[22] Adequate exposure is obtained by taking down the triangular ligament to the diaphragm so the liver may be pulled down, or by extending a midline incision into the chest across the costochondral junction of the seventh or eighth interspace and dividing the diaphragm so the entire lobe may be approached with ease. Hemorrhage may be controlled by a *temporary* gauze pack or, as first suggested by Pringle,[21] by occluding the vessels in the portal triad at the foramen of Winslow for no more than 15 minutes at a time by means of the fingers or a rubber shod clamp. The line of resection for the right lobe Fig. 1) is usually chosen to pass from the edge of the gall bladder fossa (the gall bladder being removed) to a point just to the right of the vena cava. The line of resection for the left lobe is 1 to 2 cm. to the left of this point. The middle hepatic vein, as Healy [9] and Braasch [1] have shown, lies between the right and left lobes, in the plane through the middle of the gall bladder bed down to the vena cava. By staying a little to one side of this vein, the lobar resections may be carried out in an anatomic fashion. To resect the lateral segment of the left lobe (which has been thought of incorrectly as the entire left lobe), the line of resection should be carried 1 or 2 cm. to the left or right of the falciform ligament in order to avoid the left branches of the hepatic artery, the portal vein and the hepatic ducts which run deep to the groove in the liver demarcated by the attachment of the falciform ligament.

After the line or resection has been chosen a row of 0 chromic catgut mattress sutures on a long tapered needle is placed deeply into the liver and tied firmly about 2 cm. back from the line of resection. When these are set in place, the liver is divided either sharply or bluntly to a depth slightly

superficial to the row of sutures. A method of blunt incision with a scalpel handle has been recommended by Quattlebaum,[22] and a method of "finger fracture" of the liver substance has been suggested by Lin.[15] In this manner the large vessels may be seen and ligated before they are cut with less blood loss. It is recommended that the large vessels and biliary ducts be sutured to prevent leakage which might not be completely controlled by the mattress sutures. Banks of mattress sutures are then placed successively deeper until the entire segment of liver has been divided and all large vessels and bile ducts separately ligated.

Supportive Care. In a review of 300 liver injuries, Mikesky, Howard and DeBakey[20] noted that there was a marked drop in mortality with the onset of "massive" blood transfusions. Certainly the volume of blood which has been lost from the injury must be replaced as accurately as possible in order to relieve shock. However it is our opinion that there may be harm in giving blood in the lesser injuries when it is not needed to treat shock and when there has been minimal blood loss. It has been found on the basis of clinical experience in treating minimal-to-moderate shock in many types of trauma patients that the vital signs of these patients would be restored to normal and would remain stable permanently after having an infusion of 1 or 2 L. of Ringer's lactate solution in the emergency room with no subsequent blood transfusion. This, it is felt, is due to the fact that when patients lose blood from whatever cause, they also lose functioning extracellular fluid volume. Using a triple isotope method which measures simultaneously blood volume, extracellular fluid volume and plasma volume, Shires *et al.*[24, 25] have found that in splenectomized dogs which are bled and in human beings in hemorrhagic shock there is a marked decrease in the extracellular fluid as well as in the blood volume and that the decrease in extracellular fluid is much greater than the amount of extracellular fluid lost as blood alone. This indicates that it is perhaps important to replace this extracellular fluid volume as it is to replace blood volume. It is also important to give adequate amounts of Ringer's lactate solution with the blood which is given for more massive blood losses. It has been noted that patients would not have abatement of shock even after several pints of blood until adequate amounts of Ringer's lactate had been given. In the first 4-year period in this series, 29.2 per cent of the patients did not get any Ringer's lactate solution during operation, whereas in the last 6 years, only 7.0 per cent did not get Ringer's lactate at operation, though the number receiving blood was approximately the same during both periods. There was no significant difference in the mortality rates of the two periods but it is notable that in this earlier period when less Ringer's lactate was given, there were three cases of renal failure, one of which was fatal, whereas in the later period, there was only one case of non-fatal oliguria. Also in the first period there were three cases of congestive atelectasis which were fatal, two of which occurred after large, but not excessive, transfusions of blood which were given during operation without any balanced salt solution. The third case occurred when large amounts of blood were given with very small quantities of Ringer's lactate solution. In the later period when more Ringer's lactate was given at operation there were no cases of congestive atelectasis, though the cases in each period were approximately equal in number, severity of injury and amount of blood given. Certainly this is not proof of the efficacy of balanced salt solutions in preventing the above complications but it is felt that clinically it is suggestive.

The development of pulmonary and peripheral edema or alterations of serum electrolytes even when large amounts of Ring-

er's lactate solution have been given during operation, has not been seen. By accurate replacement of blood it is thought that many patients have been spared fatal transfusion reactions, bleeding phenomena, serum hepatitis, renal failure, congestive atelectasis and other complications which occur frequently with blood transfusions—particularly large numbers of blood transfusions.

Although there is no controlled study in this series it is probably important to place all patients with liver injuries on antibiotics as soon as possible after injury in order to lower morbidity and mortality from infectious complications. Customarily in this series large doses of aqueous penicillin and achromycin have been used, usually giving the initial doses intravenously for the first 24 or 48 hours beginning on arrival at the hospital.

Complications. The incidence of prolonged biliary drainage was less in this series than in the earlier Parkland Hospital series. Probably the lower instance of biliary complications was due to more use of adequate drainage and to use of no gauze packing or other materials packed into hepatic wounds which tend to promote prolonged drainage of bile. It is likely that resection for more extensive liver wounds has reduced biliary drainage complications. The importance of suturing wounds of the diaphragm must be stressed to prevent biliary pleural effusion. However this complication can occur even when the diaphragm is sutured, since the suture may break down due to infection or insecure closure.

Mortality. The mortality for all types of liver injuries has been improved markedly for the past 50 years. The mortality in World War I was 66.2 per cent; in World War II it had dropped to 27.0 per cent; and in Korea it dropped to 14.2 per cent. The drop in mortality may be attributed to several factors. Early exploration has been more frequently performed. This has not always been so; Hinton [10] in 1929 recommended a period of watchful waiting before exploration because of fear of uncontrollable hemorrhage and infection, as well as the difficulty in repairing the liver. There is no reason for this course today, however, and a policy of watchful waiting may frequently be disastrous. Mikesky *et al.*[20] noted a striking decrease in mortality during 1941–44 when sulfonamides were introduced, and they noted another decrease in 1948–54 with the use of massive blood transfusions. Madding *et al.*,[17, 18, 19] in their review of World War II liver injuries, believed that the reduction in mortality was due to the use of large numbers of drains and the omission of gauze packs for the control of hemorrhage.

Summary

The treatment of 259 consecutive liver trauma cases is reviewed from Parkland Hospital, covering a period from 1953–1963.

Methods of diagnosis of liver trauma are discussed, including results with peritoneal diagnostic tap which were positive in 94 per cent of the cases with blunt trauma to the liver.

Methods of treatment for blunt and penetrating wounds are discussed with emphasis on drainage of all wounds, resection, use of no sutures in many cases and the concomitant use of Ringer's lactate with whole blood.

These factors have apparently decreased the mortality from liver injury: 1) early exploration, 2) use of optimal amounts of blood and electrolyte solutions, 3) adequate drainage in every case, no matter how slight the injury, 4) cessation of the use of gauze packs to control hemorrhage and use of suture and resection instead, 5) use of antibiotics in all cases.

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