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Wounds of the Liver in Vietnam:

A Critical Analysis of 254 Cases

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TREATMENT of patients with hepatic injuries has changed dramatically from that of expectancy in World War I, to the present stage of extended hepatic lobectomy. Like many advances in surgery, the experience gained from war time, by studying large numbers of patients with specific organ injury has proved invaluable. Madding, Lawrence & Kennedy[15] analyzed 829 liver and biliary tract injuries sustained during World War II. From this study the concept of adequate hepatobiliary drainage was introduced and liver packing decried.

It became apparent, after the Korean Conflict, that drainage alone was inadequate as intra-operative and postoperative hemorrhage became more common. Lortat-Jacob and Roberts'[28] early work with anatomical liver resection, followed by Quattlebaum[24] and Pack,[29] who made hepatic resection practicable, contributed greatly to the surgeons repertoire for controlling hemorrhage in liver injuries. With the increased use of high velocity weapons during the Vietnam period, resectional surgery of liver wounds became a mainstay. More difficult technical problems were added, however, such as control of hepatic vein and retro-hepatic caval injury. This necessitated rapid vascular isolation and the development of an intra-caval shunt.[25]

Theoretically, hemorrhage from the liver is controllable by resection and vascular isolation technics. As technical considerations became less of an obstacle to patient survival in Vietnam, it has become more important for the surgeon to evaluate the results of this large surgical experience. This would most expeditiously and rationally be accomplished in the form of a Vietnam Liver Registry. Such a Registry has been in operation for 1 year in the Army Surgeon General's Office.

In order to fully appreciate the potential of such a Registry, let us examine the following:

In a random study[10] of 358 Vietnam casualties with penetrating abdominal injuries, 112 patients (31%) sustained liver wounds. Jones, Peters, and Gasior[11] reviewed 1011 consecutive cases from the 2nd Mobile Army Surgical Hospital in Vietnam and reported 32 patients (30%) with liver wounds among 158 patients with abdominal organ injury. Perry[30] in a review of penetrating abdominal wounds found the liver to be the most frequently injured organ. Thirty-five patients (27%) of 131 had liver involvement. During the period from November 1967 to December 1970 approximately 22,665 abdominal ex-

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plorations were performed in Vietnam. A complete registry of Vietnam hepatic injuries could approach 5,000 cases by extrapolation.

Material Studied

Two-hundred-forty-four patients with penetrating wounds of the liver were evaluated from time of initial injury in Vietnam until discharge from a military medical facility in the United States. Ten additional patients, dying from wounds, were studied which included complete autopsy findings obtained from the Armed Forces Institute of Pathology (AFIP).

Age Incidence

The age of patients studied varied from 18 to 51. Two hundred seventeen of 234 patients were age 18 to 25 and one patient was above 40 (Table 1).

Injuring Agents

There were 94 gunshot wounds (GSW) and 160 multiple fragment wounds (MFW) in the 254 cases studied. The MFW were the results of grenade, mine, booby trap, mortar or rocket fragments. The primary small arms weapons used by the Viet Cong and North Vietnamese Army were the AK47, AK50, SKS and RDP. The M-16 and M-14 were American weapons. In Table 2 is recorded ballistic information pertinent to these weapons. From the formula $KE = 1/2\ MV^2$ (Kinetic Energy = 1/2 Mass Velocity^2), it is obvious that the velocity of the missile becomes the critical factor in determining tissue destruction or wound producing capacity.[5,32] Also, a missile will have imparted to it a rotary type motion called rotary inertia or spin which will add additional energy to its wounding capacity. This can be expressed by the formula $I = MR^2/2$ (Inertia = Mass Radius^2/2). A high velocity missile will certainly dissipate significant kinetic energy distal to its missile tract and may cause multiple organ injury. The M-16 projectile, in addition, will fragment on impact and again may add to the multiplicity of organ involvement.

Area of Liver Wound

The right lobe was injure in 67 cases and the left lobe in 34 cases. The involved lobe was not specified in the remaining 153 cases. The preponderance of right lobe injuries in survivors is most likely due to the higher rate of mortality associated with left lobe injuries because they are more likely midline and involve the cava or aorta. Another possibility is the surgeon's description of the wound based on the older anatomical classification which divided the liver at the falciform ligament instead of at the level of the gallbladder fossa and cava.[16]

TABLE 1. *Age Incidence*

Age	Patients
18–25	217
25–30	10
31–40	6
51	1

TABLE 2. *Ballistic Information on Weapons Used in Vietnam*

Weapon	Velocity (meters/sec)	Weight (grains)	Size (mm)
AK 47	710	124	7.62
AK 50	710	124	7.62
AKM	715	125	7.62
SKS	735	124	7.62
RPD	735	124	7.62
RPK	735	124	7.62
PK	825	147	7.62
RM 60	840	150	7.62
M16 (American)	972	55	5.62
M14 (American	850	150	7.62

Low Velocity less than 700 meters/sec.
Middle Velocity = 700 meters/sec. — 950 meters/sec.
High Velocity greater than 950 meters/sec.

Operative Procedure

The actual description of the liver wound was insufficiently depicted in the majority of cases and only the type of operation performed was helpful in determining the extent of hepatic damage.

One hundred eighty-eight patients (74%) of 254 had suture and drainage (S&D). Twenty-five patients (10%) had T-tubes added to the procedure of S&D. Twenty-seven patients (11%) of the total had resection or debridement. Fourteen patients (5.4%) had resection or debridement + T-tube. In the resection-debridement group there were three times as many resections performed as debridements (Table 3).

Summation of Associated Injuries

Of 254 patients, 51 (20%) had liver injury alone. One hundred seventy-nine patients (70%) were associated with other abdominal organ injury and 155 (45%) were associated with intra-thoracic trauma. In 80 patients (34%), injuries involved both intra-thoracic and intra-abdominal organs.

Besides pulmonary and multiple abdominal organ involvement, the next most common problem area was associated orthopaedic trauma. This ranged from simple

TABLE 3. *Summation of Operative Procedures*

Operative Procedure	Patients	Percentage
Suture & Drainage (S&D)	188	74
S&D + T-tube	25	10
Resection	17	6.7
Debridement	10	3.9
Resection + T-tube	13	5.1
Debridement + T-tube	1	.3
	254	100

TABLE 4. *Associated Injuries with Wounds of the Liver*

Organ System	Patients
None	51
Other abdominal organs	179
Pulmonary	115
Abdominal and Pulmonary	88
Orthopaedic	67
Vascular	18
Maxillofacial	23
Cerebral Spinal	18
Peripheral Nerve	27

fracture to a major amputation in 67 cases (26%) (Table 4).

Associated Intra-Abdominal Organ Injury

Of the 179 instances of other intra-abdominal organ involvement the most frequent injury was to the diaphragm, in 70 cases (39%). This was followed by the kidney, 54 cases (30%) and colon, 52 cases (29%). Eighty-seven patients had all types of bowel injury (48%). (A summary of all abdominal organ injuries is listed in Table 5).

Complications

The number of patients with major chest or intra-abdominal complications includes 104 cases, with a complication rate of 40 per cent. The major problem areas were postoperative infection (wound infection, sepsis, abscess or empyema) and pulmonary abnormalities. Eighty-four patients (33%) had major infections and 31 patients (12%) had significant pulmonary complications. Each specific complication in order of decreasing frequency is tabulated in Table 6.

Abscess Formation

Of 38 patients with diagnosed abscess formation, 46 separate abscesses were present for an incidence of 1.21 abscesses per patient. There were two bilateral subphrenic abscesses. Twenty-eight abscesses (60%) of 46 were subphrenic or subhepatic in origin. The next most common abscess was intra-abdominal, 10 (21%) followed by pelvic, 4 (9.5%) and intrahepatic, 4 (9.5%).

TABLE 5. *Specific Associated Intra-Abdominal Organ Injury*

Organ	Patients
Diaphragm	70
Kidney	54
Colon	52
Small bowel	32
Stomach	31
Duodenum	18
Spleen	15
Pancreas	12
Gall Bladder	11
Renal Vein	4
Bladder	3
Ureter	2
Bile Duct	2
Portal Vein	2
IVC	1
Aorta	1

TABLE 6. *Complications*

Complications	Patients
Sepsis	48
Intra-abdominal abscess	38
Pulmonary Insufficiency	31
Wound Infection	26
Stress ulcer	15
Empyema	12
Bowel obstruction	12
Biliary fistula	11
Bowel fistula	9
Falciparum Malariae	8
Cholecystitis	4
Renal failure	4
Pancreatitis	2
Defibrination Syndrome	1
Evisceration	1

The organisms cultured from the abscesses are summarized in Table 7 and show that 22 of 24 cultures were gram negative organisms compared to two gram positive cultures. The major offending agents were *Escherichia coli*, 8; proteus, 6; pseudomonas, 4; and klebsiella, 3. The only case of multiple intrahepatic abscess formation was diagnosed by liver scan and was probably amoebic in origin.

Relationship of Complication to Operative Procedure and T-tube

a. *Abscess*

After examining the results involving the relationship of operative procedure to abscess formation, we note that of 27 patients who had undergone debridement or resection without T-tube, nine (33%) developed an abscess. This represented the greatest percentage of abscess formation in any group. In the debridement or resection + T-tube group, two patients (14%) of 14 developed an abscess. From preliminary analysis it appears there is a definite preponderance of abscess formation in the group with resection and debridement without a T-tube (33%) compared to the group with resection and debridement + T-tube (14%). However, if we rigorously test our hypothesis computing the X^2 and P value we observe no statistical difference in these two groups of patients.

TABLE 7. *Results of Cultures from Abscesses*

Organism	Patients
E. coli	8
Proteus	6
Pseudomonas	4
Klebsiella	3
Staph Aureus	2
Bacteroides	1
Aerobacter	1
Amoebic	1

$$^{*}X^2 = 0.725$$
$$p > 0.30$$

Similarly comparing S&D + T-tube group with abscess, five (20%) of 25 cases, to S&D without T-tube group, 22 cases (12%) of 188 again, no statistical difference is present.

$$^{*}X^2 = 0.725$$
$$p > 0.30$$

The summation of all cases with T-tube—seven (18%) of 39—compared to cases without T-tube—31 (14%) of 215—and abscess formation also results in no statistical difference.

$$^{*}X^2 = 0.105$$
$$p > 0.70$$

If we now divide our patients according to total S&D versus total debridement or resection cases we are left with the following statistical deduction:

Total S&D patients with abscess, 27 cases (12%) of 213 cases, compared to total debridement resection patients, 11 (27%) of 41 cases, results in a definite statistical difference.

$$^{**}X^2 = 4.358$$
$$p < 0.025$$

This last calculation allows us to say the prevalence of abscess formation is certainly related to the extent of operative procedure performed and further the amount of liver destruction present (Table 8).

b. *Pulmonary Complication*

Thirty-one patients with major pulmonary complication are similarly analyzed concerning their relationship to the operative procedure. Debridement or resection—four cases (15%) of 27—compared to debridement or resection + T-tube—one patient (7%) of 14—had a major pulmonary complication.

$$^{*}X^2 = 0.043$$
$$p > 0.80$$

This shows no statistical difference.

Comparison of S&D + T-tube—six cases (24%) of 25—to S&D alone—20 cases (10%) of 188—reveals

$$^{*}X^2 = 2.53$$
$$p > 0.05$$

which is again not statistically significant but very close to being so. Comparison of total number of cases with T-tube 7 (18%) of 39, and total without T-tube, 24 (11%) of 215, again shows no difference

$$^{*}X^2 = 0.856$$
$$p > 0.30$$

If we compare total S&D group—27 (12%) of 213—with total debridement or resection group—five (12%) of 41—results are identical (Table 9).

c. *GI Bleeding*

The highest complication rate of postoperative upper GI bleeding was in those cases with debridement or resection and no T-tube present, four cases (15%) of 27. If we compare this group to debridement or resection + T-tube, 1 case (7%) of 14, no statistical difference is noted

$$^{*}X^2 = 0.04$$
$$p > 0.80$$

The remainder of cases comparing presence of T-tube with absence of T-tube show almost identical percentages of GI bleeding. A comparison of total S&D cases—ten (4.6%) of 213—with total debridement or resection group —five (12%) of 41—is very close to being significant. In this situation $X^2 = 2.2617$.

The predicted X^2 value is so close to the critical X^2 value that further sampling is necessary for any definite conclusion to be drawn. The suggestive evidence appears

TABLE 8. *Relationship of Abscess Formation to Operative Liver Procedure*

Operative Procedure	Total Number of Cases Studied 38 With Abscess	Total Number	% Abscess Formation
S & D + T-tube	5	25	20
Debridement or Resection	9	27	33
Debridement or Resection + T-tube	2	14	14
S & D	22	188	12
Total number with T-tube	7	39	18
Total number without T-tube	31	215	14
Total S & D Patients	27	213	12
Total debridement or resection patients	11	41	27

TABLE 9. *Relationship of Pulmonary Complications to Operative Liver Procedures*

Operative Procedure	31 Cases Studied Pulmonary Complication	Total Number	% of Pulmonary Complications
S & D + T-tube	6	25	24
Debridement or resection	4	27	15
Debridement or resection + T-tube	1	14	7
S & D	20	188	10
Total T-tube	7	39	18
Total without T-tube	24	215	11
Total S & D patients	26	213	12
Total debridement or resection patients	5	41	12

to be in the direction of increased upper GI bleeding following liver resection or debridement (Table 10).

In essence the establishment of T-tube drainage or controlled biliary fistula failed to cause an increased incidence of stress ulceration or GI bleeding as some authors have proposed (Foster[8]).

d. *Biliary Fistula*

Eleven cases of prolonged biliary fistula were reported. If we compare S&D + T-tube with biliary fistula—two cases (8%) of 25—with S&D without T-tube and biliary fistula—seven (4% of 188—no statistical difference is present

$$^{*} X^2 = 0.220$$
$$p > 0.50$$

The remainder of computed biliary complications, for cases with and without T-tube, as well as total number of cases with S&D compared to debridement or resection, show no difference (Table 11). From this information it appears that a T-tube will not reduce prolonged biliary fistula formation and the extent of operation performed has little effect on resultant biliary fistula formation. This problem, however, needs further evaluation because of the small patient sampling with this complication.

An interesting finding in the cases with biliary fistula was the high incidence of a fistula occurring through the chest. Five of 11 patients were discovered with this complication.

All five had associated diaphragmatic injury and inadequate abdominal drainage was an important etiological factor. It must be emphasized that in patients with diaphragmatic injury, abdominal drainage must be carefully instituted to eliminate this risk. In fact, posterior drainage through the 12th rib bed should be a major consideration in this group.

* Computation of X^2:
Level of significance = .05 = 5%
Degree of freedom = df = 1
2 Tail Test
Critical X^2 (1, .05) = 3.85

TABLE 10. *Relationship of Upper GI Bleeding to Operative Liver Procedures—15 Cases Studied*

Operative Procedure	With GI Bleeding	Total Number	% GI Bleeding
S & D + T-tube	1	25	4
Debridement or resection	4	27	15
Debridement or resection + T-tube	1	14	7
S & D	9	188	5
Total T-tube	2	39	5
Total without T-tube	13	215	6
Total S & D patients	10	213	4.6
Total debridement or resection patients	5	41	12

TABLE 11. *Relationship of Biliary Fistula to Operative Liver Procedures—11 Cases Studied*

Operative Procedure	Biliary Fistula	Total Number	% Biliary Fistula
S & D + T-tube	2	25	8
Debridement or resection	1	27	3
Debridement or resection + T-tube	1	14	7
S & D	7	188	4
Total T-tube	3	39	8
Total without T-tube	8	215	3.7
Total S & D patients	9	213	4.2
Total debridement or resection patients	2	41	5

Computed X^2 must be 3.85 or p value 0.05 for results to be statistically significant.

** Computation of X^2:
Level of significance = .025 = 2.5%
Degree of freedom = df = 1
1 Tail Test
Critical X^2 (1, .025) = 3.84
Computed X^2 must be 3.84 or p value 0.025 for results to be statistically significant.

Reoperation

This group includes reoperative cases with a diagnosis of primary liver complication rather than any extra hepatic complication such as abscess, GI bleeding, enteric fistula, etc. six (2.3%) patients of 254 studied, required re-exploration of the hepatic wound because of postoperative hemorrhage or sepsis. There were no cases of hematobilia reported in this group.

The cases were equally divided between postoperative hemorrhage or sepsis secondary to hepatic necrosis or hepatic sequestra. In two instances, a T-tube cholangiogram was very helpful in making the final decision for re-exploration. One patient had significant leakage from the left lobe and another had an obstructed major biliary duct. Both patients had sepsis and during operation revealed hepatic necrosis that required debridement. In those six individuals necessitating reoperation, suture and drainage was the original procedure in five, and left lobar resection was initial treatment in one. Five patients in the S&D group ultimately required major resection as final treatment and one patient required suture ligation of an intrahepatic bleeding point.

From these results it appears that inadequate debridement or failure to resect was the primary reason for re-exploration.

Post-mortem Studies of Liver

Of the 10 deaths following major abdominal trauma, wherein the liver was the primary organ of injury, pathologic changes in the remaining hepatic tissue were evaluated. Post-mortem liver weights were tabulated in

Table 12. If we assume the normal weight of an adult male liver to be 1500 Gm., we notice in seven of ten of the cases the weight is equal to or exceeds 2000 Gm. This is present also in those cases in which major resection was carried out.

In seven of 10 instances sectioned, sinusoidal congestion is prominent and this may, in part, account for the increased weight. This is somewhat comparable to the pulmonary edema and congestion commonly found in post-mortem lung following extensive trauma.

Another interesting finding in seven of ten cases was the presence of extensive necrosis and sequestra at the injured site which correlated with Longmire's[12] findings. Other pathologic findings consisted of fatty metamorphosis in three patients and intrahepatic abscess formation in two patients.

Case Reports

Case 1. A 51-year-old Sergeant Major sustained multiple fragment wounds in the Republic of Vietnam on 14 March 1968. He had injuries to the transverse colon, the left lobe of the liver and pancreas. Initial treatment consisted of colostomy, drainage of liver laceration plus T-tube insertion and pancreatic drainage. Postoperative course was characterized by fever, hyperbilirubinemia and sepsis. T-tube cholangiogram showed leakage from the left lobe of the liver. Three weeks following initial operation, he underwent exploration which revealed necrosis of the left lobe requiring a partial hepatic lobectomy. Postoperatively his temperature returned to normal and he was ultimately discharged.

Case 2. A 26-year-old PFC sustained a gunshot wound of the abdomen in the Republic of Vietnam on 3 June 1968. Operation revealed a lacerated diaphragm, lung, and liver. He was treated by suture and drainage of liver injury with T-tube insertion. Two weeks postoperatively a T-tube cholangiogram showed extravasation of dye and failure to fill a major portion of the biliary tree. Twelve days following this abnormal T-tube cholangiogram he began draining bile from the chest wound and an enterobacter organism was grown from his blood. His bilirubin rose to 4.8. Reexploration at this time showed a large defect in the diaphragm which could not be closed and major necrosis of the liver which was surgically debrided.

Sepsis continued with spiking temperatures and multiple abscess formation of the right lung developed. This was treated conservatively and he was finally discharged after prolonged hospitalization and multiple complications.

Comment: These two interesting cases suggest some basic points of consideration in the postoperative management of hepatic injury. In Case 1, hyperbilirubinemia, sepsis, and biliary extravasation diagnosed by T-tube cholangiogram, should alert the surgeon to a possible diagnosis of hepatic sequestration or necrosis which would certainly necessitate re-exploration. In this case, necrosis was found and resection performed with an excellent result.

TABLE 12. *Weight of Liver Post Mortem*

Patient No.	Gm.
1	4240
2	3500
3	3050
4	2750
5	2750
6	2000
7	2000
8	1800
9	1650
10	1100

In Case 2, an abnormal T-tube cholangiogram with associated hyperbilirubinemia and sepsis should have similarly alerted the surgeon to the possibility of hepatic sequestration. The presence of an abdominal biliary fistula and non-filling of a large segment of the biliary tree was allowed, however, to progress to a pleural cutaneous fistula. Certain cardinal signs that may represent necrosis such as fistula, sepsis, and hyperbilirubinemia should initiate an aggressive approach before more severe complications develop.

Also, the associated presence of a diaphragmatic injury with delayed sequestration will significantly increase morbidity.

Case 3. A 26-year-old soldier sustained a gunshot wound to the abdomen in the Republic of Vietnam on 22 September 1969. Abdominal injuries consisted of an avulsion of the right lobe of the liver near the bed of the gallbladder. The patient underwent a right hepatectomy, cholecystectomy and choledochostomy drainage. T-tube cholangiogram postoperatively revealed pooling of dye in the lateral right upper quadrant. No signs of sepsis or abnormal liver function were present. One month later a repeat cholangiogram was normal and the T-tube was removed without incident.

Comment: This instance reveals an isolated biliary fistula devoid of sepsis or hyperbilirubinemia treated successfully without operative intervention. Crosthwait, Murga and DeBakey[4] described 17 cases with excessive drainage of bile for 2 weeks or longer and in one patient bile was drained for 65 days. All of these fistulas healed spontaneously with conservative management. Again these probably represented uncomplicated isolated biliary fistulas which can be treated expectantly rather than those cases associated with sepsis and significant hepatic necrosis.

Case 4. A 19-year-old soldier sustained fragmentation wounds of the abdomen in the Republic of Vietnam. During surgery a through and through wound of the right lobe of the liver was noted. Active bleeding was not present at time of exploration. Several sutures were placed and a T-tube inserted. Post operatively the patient had a massive intra-abdominal hemorrhage. He was returned to surgery the following day where he sustained a cardiac arrest and was resuscitated successfully. Reexploration revealed an actively bleeding liver wound necessitating a 30 per cent resection. The remainder of his post operative course was uneventful.

Comment: This unusual situation may have been the result of sustained hypotension during operation or the presence of an intrahepatic clot which had temporarily tamponaded the bleeding point. All hepatic wounds should be thoroughly explored and normotension should be present before closure of the abdominal cavity. Sutures placed in a non-bleeding hepatic bed may be haz-

ardous, and initiate bleeding by tearing through hepatic parenchyma. Lobar hepatic artery ligation may control hepatic hemorrhage to the point that resection becomes unnecessary.

Case 5. A 19-year-old soldier sustained a gunshot wound of the abdomen in the Republic of Vietnam on 10 July 1968. Celiotomy revealed a through and through laceration of the right lobe of the liver which was treated by closure of the liver wound and re-enforced with falciform ligament. Three small bowel perforations and a colon injury were also present. Postoperatively he developed a wound infection. A diagnosis of falciparum malariae was entertained because of persistent temperature elevation. His fever failed to respond to anti-microbial and anti-malarial therapy and an exploratory laparotomy was performed 3 weeks after the initial operation to rule out a subphrenic collection. No intra-abdominal abscess was found at this time. Again, his condition continued to deteriorate due to the primary problem of sepsis. Five days later at reoperation an intrahepatic abscess was discovered and drained. Following operation the patient became oliguric, he developed respiratory insufficiency and succumbed.

Comment: This case points out certain basic principles in the management of hepatic injury. No liver wound should be simply closed. Any high velocity injury should be debrided aggressively regardless of surface appearances of the liver and left open with adequate external drainage. Severe hepatic necrosis may be present intrahepatically without being obvious by superficial examination of the liver surface. Before re-exploration because of diagnosed sepsis, evaluation for an intrahepatic abscess should be done with the aid of a liver scan, cholangiogram, or arteriography. As in this case an intrahepatic abscess may not be obvious at the time of exploration and it may even be necessary to needle the liver.

Case 6. A Sergeant E-5 was wounded by small arms fire in the Republic of Vietnam on 5 October 1966. He sustained fractures of the radius and ankle, laceration of the brachial artery, and a fragment wound of the right anterior chest with hemopneumothorax. Initial treatment consisted of tube thoracostomy, debridement of the chest wall, repair of vascular injury and reduction and immobilization of fractures. On 8 October 1966 the chest tube was removed and X-ray studies showed what was thought to be a right middle lobe atelectasis. The patient had a febrile course with dyspnea and absent breath sounds on the right, consistent with a consolidated right middle lobe. On 11 October a chest tube was reinserted because of complete opacification on the right and 2000 cc. of clear green fluid were aspirated. The patient responded well following this procedure and on 16 October the chest tube was removed.

One week later, that patient underwent exploratory operation because of recurrent bile thorax. A large defect of the right hemidiaphragm was closed and the liver laceration was debrided. Following operation a biliary fistula was present for 9 days but closed spontaneously. The remainder of the course was benign except for the orthopaedic and rehabilitation follow-up.

Comment: This case is an excellent example of an occult hepatic injury. All penetrating injuries of the lower chest should strongly be considered as intra-peritoneal and possibly involving the liver on the right. It has been shown during forced expiration that the diaphragm may be at the level of the 4th intercostal space.

This problem of intra-peritoneal injury following a chest wound should be thought of, especially, after a high velocity missile wound because of the significant energy wave dissipated distal to the missile tract. Bile thorax should prompt early operative intervention to close the diaphragmatic defect, with drainage instituted below the diaphragm to prevent any further serious pulmonary complication.

Discussion

Two important concepts concerning hepato-biliary surgery need further emphasis: the rational of T-tube drainage and the question of hepatic sequestration.

We retrospectively compared the relationship of T-tube decompression to four major complications: abscess, pulmonary, GI bleeding, and biliary fistula. Our statistical analysis showed no significant difference in the complication rate with respect to biliary decompression. We did, however, demonstrate a definite increased abscess formation associated with extensive hepatic injury. A trend may also exist for increased stress ulceration associated with this group of extensive hepatic trauma but no increase of pulmonary pathology or biliary fistula formation was present.

Lucas and Walt[13] reported that an increased morbidity and mortality rate existed in 18 patients with choledochostomy or cholecystostomy compared to 76 similar cases.

Table 13 shows a comparison of their randomized study with our Vietnam results. It is obvious that the number of patients studied in the Lucas and Walt group of complications (abscess, pulmonary, or GI bleeding) is too small for any serious prediction, and further sampling is needed, but a suggestion of an increased complication rate in the choledochostomy or cholecystostomy group is present. Our patient evaluation is in contradistinction to the Lucas and Walt group.

From our material three survivals and seven deaths with traumatic hepatic sequestra have been added to the

TABLE 13. *Lucas & Walt—Vietnam*

	Patients	Standard	Biliary Drainage	Patients	Standard	Biliary Drainage
Intra-abdominal abscess (and intrahepatic abscess)	8	0	8	38	31	7
GI Bleeding	3	0	3	15	113	2
Pulmonary	6	1	5	31	24	7

literature. Turrill, Donovan and Facey[6] have discussed this problem in five cases following blunt trauma. Persistent fever, unresponsive to conservative therapy, has proved to be the most common denominator of this complication. T-tube cholangiogram was very helpful in these cases either showing extrahepatic or intrahepatic extravasation. The problem could further be elucidated by the use of a liver scan. Longmire[12] points out in a study of 25 deaths from liver trauma five patients who show extensive necrosis of hepatic tissue post mortem. This also is substantiated in the evaluation of our deaths which showed severe necrosis of hepatic parenchyma in seven of 10 cases studied.

Summary

Two hundred fifty four patients with penetrating wounds of the abdomen were studied. All patients were injured by either multiple fragment or gunshot wounds in the Republic of Vietnam. A significant percentage of associated abdominal organ injury (70%) and thoracic involvement (45%) was present. Operative procedures consisted primarily of suture and drainage (84%) and debridement or resection (16%).

The major complication rate was 40 per cent. This included infection, 33 per cent, and pulmonary difficulties, 12 per cent, as the prime source of complication. No difference in complication rate was discerned based on institution of T-tube decompression.

The high incidence of hepatobiliary pleurocutaneous fistula, in the biliary fistula group, has been discussed. Emphasis on maximal drainage procedures, especially with associated diaphragmatic laceration, is pointed out. Hepatic sequestration, another interesting finding pertinent to hepatic trauma, was evaluated in three re-operative instances and seven deaths in which this finding was present. Unexplained sepsis, hyperbilirubinemia, and extravasation of contrast material aid in diagnosing this complication. Liver scintogram has been mentioned as helpful. Six cases from our overall study were presented as examples of specific errors in management and interesting problems arising from the surgical treatment of hepatic wounds.

During this initial study we have been able to increase our registry of patients with hepatic injury to well over 500 cases.

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