Blunt Trauma to the Abdomen *

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IT IS GENERALLY AGREED that penetrating wounds of the abdomen necessitate surgical intervention as soon as the patient's general condition permits. When, however, the patient suffers blunt trauma to the abdomen, the surgeon must decide whether or not laparotomy is indicated, and an incorrect decision may be catastrophic. In an attempt to determine what clinical and laboratory findings are most useful in diagnosis, which signs may be misleading, and what factors may cause an unjustified delay in treatment, the cases of blunt abdominal trauma at the University of Rochester Medical Center have been reviewed and pertinent literature has been surveyed.

Case histories of 120 patients from Strong Memorial and Rochester Municipal Hospitals have been studied. This review includes all non-penetrating abdominal trauma treated surgically or discovered at autopsy plus representative injuries managed conservatively. The sites of injury are summarized in Table I. All patients who died after sustaining multiple severe injuries and in whom abdominal trauma was of little or no importance have been excluded from further evaluation. In a smaller group of cases, death was directly due to an undiagnosed abdominal injury discovered at autopsy. These patients, whose deaths might have been prevented by surgical treatment, are included in the report and the sites of trauma listed in Table II.

Forty-nine of our patients, listed in Table III, underwent laparotomy. Seven of the cases operated upon ended fatally, the cause of death being outlined in Table IV. The accidents producing these injuries are summarized in Table V. Accidents reported in the literature parallel these but also include certain oddities such as injury from a pneumatic drill [7] and from the high heel of a shoe in the hand of an irate wife.[55]

Any abdominal structure may be damaged by non-penetrating trauma, and many bizarre injuries have been reported. However, the organs most commonly injured in this way are the kidney, spleen and liver.[11, 19, 20, 81] Since injuries to the kidney can usually be managed conservatively, rupture of the spleen is the most common single entity requiring operation. Our series, in which splenectomy was done in 32 of 49 cases undergoing operation, bears this out. The frequency of hepatic damage varies considerably from one series to another. Excluding those patients with multiple injury in whom operation was out of the question, only three patients with surgically significant trauma to the liver or extrahepatic biliary system were encountered at this center. The two patients who sustained major wounds of the liver both died of hemorrhage. The one patient with injury of the extrahepatic biliary system recovered satisfactorily and has been reported elsewhere.[21] Welch and Giddings [81] reported that 9.5 per cent of their 200 patients sustained hepatic injury, and other figures [11, 28] agree closely with theirs. However, at Har-

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TABLE I. *Cases of Blunt Abdominal Trauma Reviewed, University of Rochester Medical Center*

Site of Injury	No.
Spleen	37
Liver	5
Pancreas	2
Gastro-intestinal tract	13
Kidney	26
Urinary bladder	4
Abdominal wall	3
Retroperitoneal space	2
Multiple severe injuries	32
Total	120*

* Multiple involvement in 4 cases: (1) spleen and left kidney, (2) spleen and stomach, (3) pancreas and stomach, (4) ileum, bladder and urethra.

TABLE II. *Cases Diagnosed at Autopsy (Surgical Treatment Potentially Curative)*

Site of Injury	No.
Spleen	5
Liver	2
Gastro-intestinal tract	1
Urinary bladder	1
Total	9

lem Hospital,[85] over 33 per cent of the patients with intra-abdominal injury sustained significant hepatic damage.

Rupture of the spleen is a well recognized entity which has been extensively reported.[38, 45, 77, 84] The usual case requires early operation to prevent exsanguination, but cases are encountered in which rupture and hemorrhage are late events. MacAuley [43] reported a patient in whom the spleen was entirely avulsed from its pedicle, but massive hemorrhage was prevented by early thrombosis of the severed vessels. The spleen was removed more than 24 hours after injury primarily because of abdominal pain. Delayed rupture following subcapsular hematoma is reported in about 14 per cent of cases.[88] Although this commonly occurs during the first two weeks following trauma [48] occasional patients have minor undiagnosed difficulties over long periods of time. One of our cases was hospitalized elsewhere for three weeks after injury during which time he complained of intermittent abdominal pain. One week after his discharge he was admitted to Strong Memorial Hospital with abdominal tenderness, leukocytosis and hypotension. At operation both fresh and organized hematomas were found around a lacerated spleen. Another patient entered the hospital with a two year history of crampy abdominal pain and loss of weight. He was discovered to have marked anemia and a left upper quadrant mass. Pathologic examination of the specimen removed at laparotomy showed an old hematoma surrounding an atrophic spleen. Olander and Reimann [53] reported a patient with symptoms beginning two years after the only known abdominal trauma. Operation six months after the onset of symptoms disclosed a hematoma surrounding a spleen which had apparently been bleeding intermittently. Schwartz [67] reported a large symptomatic cyst of the spleen which he believed to be the late result of a subcapsular rupture. One of the unusual late events following rupture of the normal spleen is the implantation of splenic tissue throughout the peritoneal cavity,[40, 72] and secondary intestinal obstruction may result from this.

All authors agree that mortality from rupture of the liver is very high.[23, 24, 85] The relatively low incidence of liver trauma in various hospital series is probably due to death from hemorrhage at the scene of the accident in many severe hepatic injuries.[65] When central or subcapsular hepatic rupture occurs, later biliary tract hemorrhage may result.[27, 64, 73] These patients present a puzzling picture of intermittent major gastro-intestinal hemorrhage, biliary colic or incomplete extrahepatic biliary obstruction. Hemobilia may also follow surgical repair of rupture of the liver.[18] Symptomatic intrahepatic bile cysts following subcapsular rupture have been reported.[54] The

extrahepatic bile ducts may be injured in the absence of damage to the liver or other organs.[46, 66] These patients may have mild intermittent symptoms with consequent delay in diagnosis and treatment. Both immediate and delayed rupture of the gall bladder have occurred,[3, 15, 50, 52, 71] although injury to the liver or the bile ducts is more common. Cholecystectomy has been accomplished with almost surgical precision by blunt trauma to the right upper quadrant.[6, 44, 55] In two of these cases the gall bladder was recovered from the pelvis at laparotomy.

Shallow and Wagner [69] reported that non-penetrating abdominal trauma accounts for two to four per cent of cases of acute pancreatitis, but our own figure is not nearly this high. Pancreatitis is more common following blunt than penetrating trauma [49] and may be produced by a trivial accident.[36, 80] Symptoms may be immediate but are often delayed for 72 hours or even longer.[36] Most commonly the organ is contused but laceration or complete transection may occur.[36] Pancreatic calcification and pain have been reported as late sequelae following blunt abdominal injury [37] although most cases of this syndrome are not associated with known trauma.[33]

Any part of the gastro-intestinal tract may be damaged by blunt trauma, although gastric injury is rare.[82] The sites of injury in our 13 cases with gastro-intestinal trauma were as follows: stomach two, retroperitoneal duodenum one, jejunum four, jejunum and ascending colon one, ileum two, transverse colon one, descending colon one, sigmoid colon one. The only ruptures at fixed points in the bowel were those in the fourth portion of the duodenum and in the sigmoid colon at the peritoneal reflection. Most of the small intestinal ruptures occurred along the anti-mesenteric border although in one instance the mid-jejunum was completely transected. Counseller and McCormack [16] found that 80 per cent of non-penetrating intestinal injuries occurred in the jejunum and ileum, ten per cent in the duodenum and four per cent in the large bowel. These figures have not been significantly changed by later reviews.[4, 56] Injuries of the retroperitoneal duodenum have attracted special interest because of the difficulty in diagnosis even at laparotomy.[12, 20, 61] Siler [70] reported one patient with duodenal injury in whom operation was not performed until five months after injury. At this time a large walled off

TABLE III. *Non-Penetrating Abdominal Trauma, Surgical Cases*

Site of Injury	No. of Cases	Fatalities
Spleen	32	4
Liver and biliary tract	3	2
Gastro-intestinal tract	12	2
Pancreas	2	0
Kidney	2	0
Urinary bladder	1	0
Retroperitoneal space	1	0
Total	49*	7*

* Multiple involvement in 4 cases (1 fatal): (1) spleen and left kidney, (2) spleen and stomach (fatal case), (3) pancreas and stomach, (4) ileum, bladder and urethra.

TABLE IV. *Deaths Following Operation*

Site of Injury	No.
Spleen 4	
Multiple injuries*	1
Bronchopneumonia	1
Tension pneumothorax, untreated	1
Late bowel infarction, unrecognized	1
Liver 2	
Hemorrhage	2
Gastro-intestinal tract 1	
Late diagnosis	1

* Rupture of stomach and open chest wound also present.

TABLE V. *Type of Accident*

Automobile	33
Fall	17
Struck by car	14
Blow to abdomen	13
Sled	6
Unknown	3

retroperitoneal abscess was present and the initial diagnosis was a perforated carcinoma of the ascending colon. Unusual injuries of the bowel include two cases of traumatic appendicitis,[7, 22] the expulsion per rectum of a segment of gangrenous ileum,[2] and an example of jejunal obstruction from subserosal hematoma.[39] Two additional reports [32, 42] described intestinal obstruction due to the trapping of a loop of small bowel between injured bony structures.

Rather than affecting the bowel directly, injury may involve primarily the mesentery and blood supply.[29, 32, 78] In one of our cases of injury to the ileum the mesentery had been torn away from a nine centimeter length of bowel which was otherwise undamaged. The second case of ileal injury was misdiagnosed until very late in its fatal course, and the damage was probably of this same nature. Mesenteric damage may result in late perforation of the bowel several days after injury.[26] One of our patients showed at laparotomy shortly after injury a large retroperitoneal hematoma involving the descending mesocolon, but the bowel wall itself appeared viable. Six days later perforation of this segment necessitated an emergency left colonic resection. Chylous peritonitis may also occur secondary to mesenteric injury.[41]

Only the most severe lacerations of the kidney require nephrectomy for the control of hemorrhage. Conservative management in milder injuries gives uniformly good results.[74] Postmortem examination of two of our patients who died of head injuries shows why conservative management is so successful. Both patients had gross hematuria within 48 hours of death, but the only lesions of the urinary tract demonstrable at autopsy were a minute calyceal fracture in one and several small, shallow lacerations of the kidney parenchyma plus a perirenal hematoma in the other. One of our two patients treated surgically sustained a laceration which divided the superior pole from the remainder of the left kidney and extended down into the renal vein. The second patient developed hematuria several days after being gored by a bull. Because hematuria recurred intermittently for six weeks and because retrograde pyelograms showed a mass in the superior pole of the right kidney, he was explored. A bifid ureter was present with the upper one leading from a huge hydronephrotic sac which contained an organized hematoma and bloody fluid. The lower ureter communicated with the rest of the kidney and a fracture of its upper calyx with hematoma formation was present. The kidney was removed. A most unusual occurrence following trauma was the complete transection of a horseshoe kidney reported by Corcoran.[13] Non-penetrating damage to the ureters is extremely rare and almost always associated with other major injury. Rusche and Hager [63] reported two cases of this type. Either intraperitoneal or extraperitoneal rupture of the urinary bladder may be produced by trauma.[58] In the majority of cases an associated pelvic fracture is present,[14] and bony fragments projecting through the bladder wall may prevent healing. One of our fatal cases might possibly have survived if a small bladder perforation with pelvic peritonitis had been recognized and treated.

Direct trauma to the adrenal glands, in the absence of other serious injury, must be extremely rare. Sevitt [68] recorded post traumatic adrenal hemorrhage occurring, he felt, as a primary effect of trauma. He reported that crushing injury to adrenal vessels led to multiple focal hemorrhagic areas in the adrenal substance. Although adrenal hemorrhage was present in several of our fatal cases, it is impossible to determine what part this played in the patients' deaths.

Rupture of the uterus from abdominal trauma has occurred only during pregnancy, and even then it is rare. McClure [47] recorded one case and mentioned less than 50 others from the literature. Woodhull's

patient [83] underwent operation one month after injury. A macerated fetus was found in the pelvis outside a badly torn uterus. Vaginal bleeding had not occurred in this patient and was minimal in McClure's case.

Injury to the great vessels in the abdomen is rare. Strassmann,[75] in reviewing 72 ruptures of the aorta from blunt force, found only three cases involving its abdominal portion. Traumatic aortic aneurysms have occurred in the thoracic aorta,[25] but no case has been reported involving the abdominal aorta. Only penetrating wounds of the inferior vena cava are on record although caval thrombosis following abdominal trauma may at times have been due to an unsuspected injury of the vessel wall. At least one case of portal vein thrombosis following trauma is on record.[30]

DIAGNOSIS, AIDS AND PITFALLS

Whenever a patient complains of abdominal pain following non-penetrating abdominal trauma, the physician is confronted with a diagnostic problem. If a serious intra-abdominal condition is overlooked, delay may lead to long morbidity or to a fatal outcome. If a minor injury is misinterpreted, an unnecessary laparotomy may be performed. If the patient has major injuries elsewhere, this unnecessary procedure may be extremely ill advised. To aid the physician in his decision, a variety of diagnostic procedures has been suggested.

An accurate history and repeated thorough physical examinations are of primary importance. The type of trauma sustained may give a clue to the potential severity of the injury but it can also be misleading. One of our patients suffered a ruptured spleen by falling off a couch; another completely transected his jejunum during the simple act of bowling. The type and location of pain are important although localization of pain does not always indicate the site of injury. Injuries in the diaphragmatic area may be suggested by shoulder pain, in the retroperitoneal area by testicular pain and priapism. However, one of our patients with shoulder pain as a primary complaint proved to have only an abdominal wall contusion. A latent period between injury and onset of symptoms may be important in the diagnosis of such abdominal injuries as subcapsular ruptures and retroperitoneal injuries. This has been emphasized in retroperitoneal ruptures of the duodenum by several authors,[12, 61] but it is not an invariable rule since our one patient with this injury had steady, severe pain from the time of accident. A history of vomiting blood or of passing bloody stools or urine may aid in localizing damage. The constant desire to void with inability to do so is almost pathognomonic of bladder or urethral injury.[14] Dyspnea is commonly a prominent symptom with splenic rupture, but this is rarely useful in diagnosis since other causes for dyspnea, particularly fractured ribs, are so frequently present concomitantly.

The prominent physical findings to be anticipated are those of shock and of peritoneal irritation. Although retroperitoneal hemorrhage may produce this combination, it is usually indicative of a lesion necessitating operation. Shifting dullness, if present, is a valuable sign. The harder problem is presented by the patient in whom signs are less pronounced or are masked by trauma elsewhere. The full blown picture of shock is not an early event in most abdominal trauma, and a plan of therapy should be established before it occurs. With certain injuries of surgical importance, particularly the retroperitoneal ones, the usual signs of parietal peritoneal irritation may be entirely lacking. Profound shock may also obscure the picture. In one of our patients with a ruptured liver, abdominal examination was unremarkable at the time of hospital admission. Several hours later, after blood transfusion, there was obvious evidence of intraperitoneal fluid, and at laparotomy major hemorrhage from a massive rupture of the liver was discovered. Trauma

to either the abdominal wall or viscera usually produces a decrease in peristaltic activity, but continued peristalsis has been reported even after rupture of the intestine.[43]

The findings from routine laboratory investigation are equally inconclusive. Some degree of anemia is the rule after these injuries, but exceptions are numerous. Anemia, when present, does not determine the type of injury or its proper management. Leukocytosis is similarly non-diagnostic. Elevation of the white blood count is a common finding with intra-abdominal hemorrhage but is not rare with hematomas of the abdominal wall or with kidney damage, neither of which requires operation in most cases. The white blood count may be normal, although rarely so, with any of the more serious intra-abdominal injuries. Examination of the urine for red blood cells is important in establishing the presence of injury to the urinary tract. Hematuria is ordinarily noticed early and frequently leads the patient to seek medical advice, but its appearance is occasionally delayed for several days. Once present, it usually disappears slowly over nine or ten days, but infrequently stops as abruptly as it began. When a patient is unable to void, cautious catheterization of the urinary bladder for diagnosis is desirable. The immediate return of abnormally large volumes of fluid is considered indicative of bladder rupture.[10] It has been suggested [28] that sterile saline be injected through the catheter and then aspirated, the recovery of an equivalent amount of fluid being viewed as evidence of integrity of the bladder wall. This practice is generally condemned,[34, 58] both because of the danger of further extravasation and because the recovery of equivalent or greater amounts of fluid can occur with bladder rupture. Failure to appreciate this fact led to a fatal misdiagnosis in one of our patients with a bladder rupture. The attempt to pass a cystoscope as a diagnostic aid is not advised.[58] Elevation of the level of serum amylase following trauma is indicative of pancreatic damage but it does not, of course, rule out other abdominal pathology. The value of serum amylase determinations in non-penetrating trauma is thus somewhat limited.

In an effort to establish a more accurate diagnosis, abdominal paracentesis has been advocated. Byrne,[9] who advises tapping each of the four abdominal quadrants with a small needle, reported 83 per cent accuracy with this technic. Even in his hands, however, the paracentesis was negative in eight cases where a ruptured spleen was removed at laparotomy and in two with injuries to the small intestine. The recovered material is usually bloody fluid, but air, intestinal contents or bile-stained fluid may also be found. If traumatic pancreatitis is suspected, the amylase activity of the fluid can be measured. Amylase activity usually reaches higher levels in abdominal fluid than in serum, but the elevation may not occur for two or more days after injury.[9] Paracentesis may be misleading even when positive. In one of our cases bloody fluid was recovered, but at operation it was discovered that this fluid had been aspirated from an unusually large retroperitoneal hemorrhage rather than from the peritoneal cavity. Needle paracentesis was performed in 25 of our patients who underwent subsequent laparotomy, and positive taps were reported in 16. However, non-diagnostic taps were recorded in six of the 15 ruptured spleens and in three of the seven intestinal injuries in which paracentesis was done. One patient with a negative tap had more than one liter of blood free in the peritoneal cavity when a ruptured spleen was removed a short time later.

Several types of x-ray examination have been suggested as aids in diagnosing abdominal injuries. The most commonly employed are the plain film of the abdomen and the upright or lateral decubitus film for free air.[35] Haziness of the plain film may suggest free abdominal fluid, but even large amounts of fluid may be impossible to de-

tect.[87] Obliteration of renal outlines or of psoas shadows suggests retroperitoneal edema or hemorrhage.[79] The gas pattern in the gastro-intestinal tract can be evaluated, and a search can be made for injuries frequently associated with the intra-abdominal pathologic conditions. These include fractures of ribs, lumbar transverse processes and the bony pelvis. The finding of collections of retroperitoneal gas is indicative of extraperitoneal injury to the duodenum, but the films in our case were not diagnostic. Wyman [87] felt that enlargement of the splenic outline following trauma was pathognomic of splenic injury and that it was a reasonably constant early sign. He considered serration of the greater curvature of the stomach, a sign mentioned by many authors, to be an unusual finding. Wang and Robbins [79] concluded that the presence of a small, well outlined spleen on a good plain film practically rules out splenic injury even with a history of abdominal trauma. The free air films have been disappointing in the diagnosis of traumatic intestinal rupture. For example, Jacobson and Carter [31] found subdiaphragmatic free air in only two of 16 small bowel perforations, and because of the paucity of positive findings they considered x-ray examination of little value in excluding intestinal injury following blunt trauma. Intravenous pyelography and retrograde cystography may be of considerable value in diagnosing injuries of the urinary tract. Many patients with renal trauma have normal intravenous pyelograms even in the period immediately after trauma, but the damage in these cases is usually slight and they can be managed conservatively. The demonstration of a contralateral kidney with normal function is of paramount importance in the unusual case where nephrectomy must be considered. Gravity cystograms, if carefully done, can demonstrate bladder injuries with minimal risk. They provide the best method of establishing this diagnosis.[14] Twenty-eight of our patients requiring operation were examined with the usual roentgenologic techniques, and positive or suspicious findings were present in ten. Findings were negative in 14 of the 19 cases of splenic rupture and in four of the six intestinal injuries in which x-ray studies were done. We have been less successful in establishing the diagnosis of ruptured spleen by plain abdominal films than have some authors, but our negative findings in intestinal injury parallel the experience of others.

Several other x-ray technics have been reported occasionally. The use of a lipiodol swallow to demonstrate tears of the retroperitoneal duodenum has been recommended.[20] The ingestion of barium to outline the greater curvature of the stomach and to demonstrate gastric displacement in suspected splenic injuries has been suggested.[1, 79] Rudolph [62] reported an unsuccessful attempt to evaluate possible splenic injury by percutaneous splenoportal venography, and Burke and Madigan [8] attempted to diagnose hepatic and splenic injuries by the intravenous injection of Thorotrast® followed by abdominal films in several hours. Estes [19] found the latter technic of some value in cases of ruptured liver. None of these technics has been widely employed and, with the possible exception of the lipiodol swallow, their further use seems unwarranted in the acutely injured patient.

Using the combination of paracentesis and appropriate x-ray examination, the surgeon can make a proper decision in most difficult cases where clinical judgment alone is not conclusive. In our series both methods of study were used in 17 of the patients undergoing laparotomy, and both were negative in only four. The four failures occurred in two of the ten splenic ruptures and in two of the four intestinal injuries in which both tests were performed. Thus, in a certain small number of patients an exploratory laparotomy must be undertaken as a diagnostic procedure.[57] Careful examination at the operating table should demonstrate readily any intraperitoneal

damage, but retroperitoneal injury may produce no intraperitoneal pathologic change. Duodenal trauma has been frequently overlooked at operation with disastrous results.[51] This injury should be suspected whenever there is emphysema, hematoma or bile-staining of the transverse mesocolon or of the posterior parietal peritoneum. In the presence of any of these signs the duodenum should be mobilized so that its entire length can be visualized. Even when bile-stained fluid is found in the peritoneal cavity, the site of rupture in the biliary system may not be apparent. The use of operative cholangiography should be helpful in this situation.

There is no easy road to establishing the proper diagnosis in these interesting but difficult cases. Attempts such as that of Knopp and Harkins [38] to describe the "typical ruptured spleen patient" represent an ill-advised use of statistics and may give a false sense of security to the unwary. The surgeon must realize that diagnostic aids are of importance only when they are positive. Careful, repeated physical examinations and thoughtful analysis of each case still afford the best opportunity for correct diagnosis.[76]

OPERATIVE TREATMENT

Once the decision for laparotomy has been reached, the surgical management often presents no major problem. However, the difficulty in reaching this decision led Breidenbach [5] to feel that penetrating abdominal wounds, all of which require operation, are usually better managed than non-penetrating ones. Many authors [11, 56, 57] agree with this point of view and urge that exploration be done whenever a well founded suspicion of intra-abdominal injury is present.

The treatment for ruptured spleen is, of course, splenectomy. It has been estimated [59] that the mortality without operation is at least 90 per cent. The practice of packing or suturing a ruptured spleen has been long abandoned because of the frequent occurrence of subsequent hemorrhage.

Although most surgeons now feel that patients with lacerations of the liver should undergo early operation, conservative management is still advocated by some.[19] In operative management the surgeon's prime consideration is the control of hemorrhage, but how this can be most safely accomplished with the least morbidity will vary according to the location and severity of the injury. Small rents may be closed,[28] but obviously necrotic tissue should be removed before placing the sutures. Dependence on Oxycel® gauze or Gelfoam® as a definitive treatment can not always be avoided when dealing with large lacerations. If a foreign substance or necrotic tissue must be left in the liver, subsequent escape of bile can be expected and the abdominal cavity should, therefore, be drained. Fragments of liver tissue may appear in the drainage.[65] Sparkman [73] suggests that hemobilia occurs as a complication of the treatment of lacerations of the liver because bile under pressure in the resulting cavity may produce continued autolysis of the lining hepatic tissue. Since surgical decompression of the biliary tract is the recommended treatment for this complication, perhaps it might also prevent its occurrence. The only alternatives seem to be close apposition of viable liver tissue, which is desirable anyway, and drainage of the potential cavity below the sutured surface. The latter has the disadvantage of other packing methods, the possibility of secondary hemorrhage after removal of the packs. The inadvisability of suturing lacerations which extend almost through the substance of the liver is demonstrated by one of our cases in which a major portion of the left lobe was all but completely transected. Although suturing provided temporary hemostasis, at autopsy the disrupted fragment was completely necrotic. Removal of the injured tissue would have been bet-

ter treatment. Large lacerations in the dome of the liver may best be approached through a thoraco-abdominal incision.[17] Although plain gauze packing is frequently condemned, if the surgeon is unable to control hemorrhage by more desirable means he should be prepared to do this. Before resorting to this least satisfactory form of treatment, however, he should think of the invariable complication of secondary infection and the frequent one of subsequent hemorrhage.

Injury to the extrahepatic bile ducts usually requires little more than an escape route for the leaking bile, and decompression of the ducts with a catheter in the common duct or gall bladder. Subsequent cholangiography should be used to check the integrity of the duct. The usual lesion will not require operative repair either primarily or secondarily, and, if the rent is small, primary suturing may be inadvisable.

Traumatic ruptures of the gall bladder may require cholecystectomy, but cholecystostomy or suture of the rent may also be satisfactory.[71] The treatment will depend on the injury but is, in any case, no problem.

Isolated pancreatic injury, if the diagnosis can be established, is not an indication for immediate operation but it may lead to late complications despite the initial treatment.[80] An obvious tear, discovered at operation, should be sutured to prevent further bleeding or leakage of pancreatic secretions,[34] and drainage of the lesser sac might render subsequent development of a pseudocyst less likely. Both of our cases of traumatic pancreatitis required drainage of a collection of fluid in the lesser sac three weeks after the initial trauma. Uneventful recovery followed in each instance.

Injuries to the gastro-intestinal tract and mesentery should be managed by suture of lacerations, resection of bowel, sidetracking anastomosis, exteriorization or control of hemorrhage as the individual case demands. The surgeon should not overlook the possibility of multiple injuries merely because one site of damage is readily apparent. The chief complications which may be avoided by the choice of the correct procedure are stenosis at the site of injury and delayed perforation subsequent to impairment of the blood supply. Stenosis is less likely if the more extensive injuries are treated by bowel resection rather than by simple closure. Our case of damage to the mesentery of the descending colon demonstrated the difficulty of determining the adequacy of the remaining blood supply. Here the surgeon convinced himself that the segment of colon was viable but, nevertheless, on the sixth day after injury had to reoperate because of delayed perforation. In retrospect, this combination of contused bowel and decreased blood supply would have been better handled by exteriorization or resection.

Only the most severe lacerations of the kidney demand immediate operation to prevent exsanguination. Although bleeding may at times be controlled by pressure or suturing, injury involving the renal pedicle, similar to that in one of our cases, requires nephrectomy. That later nephrectomy may be necessary following renal trauma is illustrated by our case described in a previous section.

Rupture of the urinary bladder requires immediate operation. The perforation should be closed and a suprapubic cystostomy done, but if the injury can not be readily located or is found in an inaccessible area, cystostomy alone will suffice.[34, 58] Bony spicules which may extend from a pelvic fracture into the bladder must be removed to permit satisfactory healing.

Rupture of the pregnant uterus can usually be handled by extraction of the fetus and placenta followed by repair of the lacerated uterus. In the severely ill patient, however, hysterectomy may be faster and safer than attempted suture of a large tear in the vascular uterine wall.[83]

Injury to vital blood vessels would ordinarily be treated by repair or replace-

ment of the involved segment. An interesting example is Ulvestad's patient [78] in whom suture of the superior mesenteric artery successfully controlled hemorrhage and prevented massive bowel gangrene.

In 1931 Robertson [60] reviewed the literature and his own experience in an attempt to determine the best management of nonpenetrating abdominal trauma. Today there is still no argument with certain of his conclusions. For example, differential diagnosis remains difficult and often impossible; each case presents a different problem and should be dealt with accordingly; and any trauma involving the abdomen calls for critical study and careful observation. However, surgeons no longer agree that conservatism is usually the best policy. The availability of blood for transfusion and the advances in anesthetic technic today permit earlier operation with consequent greater hope for cure in some of the seriously injured patients.

The rumble seat concerned Robertson in the same manner that the steadily increasing horse power of current automobiles worries the surgeon of today. Unless safer cars or saner drivers are designed, the surgeon can anticipate an increasing number of these difficult cases as the years go by.

SUMMARY AND CONCLUSIONS

The records of 120 patients seen at the University of Rochester Medical Center after blunt abdominal trauma have been reviewed. Our experience in the diagnosis and care of these patients has been compared with that of others.

The injuries, common and bizarre, which may result have been described and their treatment discussed. Various diagnostic aids may be of help when positive, but our study shows that negative findings with major injury are too common to permit great reliance on any of them. Correct diagnosis and proper management are dependent upon individual evaluation of each patient. In this evaluation a careful history and thorough physical examination still provide the best information for minimizing error.

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DISCUSSION.—DR. RUDOLPH M. LANDRY, Chattanooga, Tenn.: I enjoyed Dr. Morton's paper on abdominal trauma very much. We have been interested in the problem for some time, and it is very much of a problem particularly when it is associated with multiple injuries. To illustrate this I would like to tell of one case we have recently had, a young girl who was in an automobile accident, and was admitted to the hospital in a comatose condition. The pupils were dilated, the right chest was not aerating well, and x-ray proved a partial pneumothorax. Immediate tra-