The Management of Duodenal and Other Small Intestinal Trama

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One hundred sixty-three patients were treated for blunt and penetrating trauma of the duodenum and small bowel over a 4½-year period at a major trauma center. Blunt injuries, mostly a result of vehicular trauma, comprised 17% of the cases, while stabbing and firearm injuries made up the remainder. Laboratory data, including white blood cell count, amylase, and abdominal x-rays, were unreliable in predicting the presence of intestinal injury. Although only obtained in a few patients following blunt injury, computerized tomography (CT scan) of the abdomen was sensitive to intraperitoneal findings suggestive of or diagnostic for gastrointestinal injury. Speedy operative management is of the utmost importance; 63% of these patients were operated on in less than 2 hours from the initiation of medical treatment. The majority of intestinal damage can be repaired by simple closure or resection. Because of anatomic and physiologic considerations, complex operative procedures are required for the correction of some duodenal lesions. Our treatment of these injuries included frequent utilization of pyloric exclusion, as well as occasional diverticulization of the duodenum and pancreaticoduodenectomy. Delay in treatment and the magnitude and number of associated injuries contributed to increased morbidity and mortality, which was much higher in blunt trauma (21% versus 4% for penetrating injuries), especially when the duodenum was involved (36% mortality). Complications were also more common in the patients following blunt trauma and with multiple injuries. Infectious complications were the most frequent, with postoperative ileus or obstruction, hemorrhage, and iatrogenic complications occurring less often. In the majority of small bowel injuries, the management is straightforward and consists of operative repair as soon as possible. A high index of suspicion and reliance on diagnostic aids, such as CT scan, will speed the diagnosis of occult blunt intestinal injuries. Sound surgical judgment and facility with a variety of repairs is needed in the treatment of complex duodenal injuries.

Injuries of the duodenum and small bowel are frequently seen at major urban trauma centers, usually as a result of firearms, stabbings, and motor vehicle accidents. After the liver the intestines are the most commonly injured organ in penetrating injuries; only the spleen and liver are more frequently damaged in blunt trauma [1]. Mortality from penetrating intestinal injuries has dropped dramatically in this century, largely as a result of more rapid recognition and treatment [2–4]. The mortality of blunt intestinal trauma remains about 3 times that of penetrating injuries, due to the magnitude of force involved, the delay in diagnosis, or both [5]. Injury of the duodenum, because of its protected position and the close proximity of other vital organs, occurs with multiple other injuries in a significant number of cases [6, 7]. In addition to the presence of several injuries, delayed recognition of the injured duodenum results in increased mortality [6–8]. In all forms of intestinal trauma, physical findings and laboratory data are not wholly reliable in detecting injuries [2, 6–15].

We have examined the treatment of duodenal and other small bowel injuries at a major trauma center for a 4½-year period. Included in this analysis are the mechanisms, locations, and types of injuries; diagnostic tests obtained; the time elapsed until operative treatment; the surgical management; and the morbidity and mortality of these injuries.

Methods

The charts of all patients admitted from January 1979, to June 1984, coded for either blunt or pene-

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Table 1. Patient population.

Injury	No. of patients	Sex M	Sex F	Ages (years) Age range	Ages (years) Mean age	Ages (years) Median age
Blunt	28	25	3	8–85	39.6	31
Stab	74	67	7	17–77	32.5	30
Firearm	61	52	9	13–70	31.1	30
Total	163	144	19	8–85	33.4	30

trating duodenal or small intestinal trauma were requisitioned; 163 patients were found to have sustained such injuries and their records were subsequently reviewed. Patient age and sex, mechanism of injury, dispatch time of ambulance or approximate time of trauma, symptoms, physical findings, laboratory values (white blood cell count, amylase, flat plate and upright abdomen), special studies (upper gastrointestinal series, computed tomography scan, peritoneal lavage), time of surgical incision, operative findings and management, and outcome (including death, complications, and duration of follow-up) were recorded.

Results

Patient Population

The vast majority of patients sustaining blunt or penetrating abdominal injuries involving bowel were young males (Table 1). This is in total agreement with multiple other studies. Patient age ranged from 8 to 85 years, but the median age for trauma due to blunt injury, stabbing, or firearms was 30 or 31 years. Of those injured, the majority suffered penetrating trauma, with 45% having been stabbed with a knife (68 patients) or other implement (4 ice picks, 1 coat hanger, and 1 pipe) and 37% shot with some form of gun (59 shot by handguns and 2 with shotguns). Most of the penetrating injuries were the result of a single abdominal wound (81% of the stab and 84% of the gunshot patients), but fully a tenth of these patients (11% stabbing and 8% firearms) received 2 wounds which entered the abdominal cavity. The remaining 8% of both groups had three or more abdominal wounds capable of injuring the bowel. Seventeen percent of the patients' injuries were the result of blunt trauma, mostly the result of motor vehicle accidents. Of the 28 patients in this group, 13 were the driver or passenger in a vehicle, 6 others were struck by an automobile or truck. There were also 4 assault victims, 2 people who fell, an injury sustained after running into a chain, a rodeo injury, and a young man who had a barbell fall on his abdomen while lifting weights.

Symptoms and Signs

All patients were examined and resuscitated in our emergency room prior to further studies or operation; however, documentation of patient pain was frequently unavailable. Less than half of the patients with penetrating injuries were documented as experiencing abdominal discomfort, although the actual incidence was probably higher (Table 2). Since routine exploratory laparotomy of wounds felt to penetrate the peritoneum is performed at our institution, this information may not have been routinely sought in these circumstances. This was in contrast to blunt injuries in which 82% of patients had abdominal pain on presentation. The remainder either developed abdominal discomfort or were comatose or uncooperative preoperatively. Twenty-one percent of this group also complained of nausea or vomiting; 5 of these 6 patients presented several hours to days after their injuries. Those patients who had vomited in the penetrating injury groups were intoxicated in 1 case and vomited blood in the other 2. Changes in bowel habits were noted in 2 patients, diarrhea in a man admitted 2 days after an ice pick wound to the jejunum and hematochezia in a man who had an ileocolic intussusception due to a hematoma suffered in an assault with a baseball bat the day before admission.

Abdominal tenderness to examination was again more commonly found in the blunt trauma group (86%) but was noted in 64% of those shot and in 46% of those patients stabbed. Guarding or abdominal rigidity was noted in 75% of the blunt injuries, a third of the gunshot wounds, and only 15% of those people stabbed. Rebound tenderness was again more common in the blunt trauma group, although it was present in this cohort only 18% of the time. Patients presenting in shock (systolic blood pressure of $\leq$ 90 mm Hg) comprised a third of the entire study population, representing approximately a quarter of both blunt trauma and stabbing patients and nearly half of the gunshot victims.

Laboratory Findings

Complete blood cell counts were drawn from almost all patients on arrival in the emergency room. Elevation of the white blood cell count above 10,000/ml occurred in only half of the patients overall, with higher frequency in blunt and stab injuries (Table 3).

An abnormally high serum amylase level, suggestive but by no means diagnostic of pancreatic or intestinal injury, occurred most often in blunt trauma (52%), less than a quarter of the time in gunshot wounds, and rarely with stab wounds. Four of the 11 elevated amylase levels occurred with

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World J. Surg. Vol. 9, No. 6, November 1985

Table 2. Symptoms and physical signs.

	Symptoms		Physical findings			
Type of trauma	Pain	Nausea/Vomit	Tenderness	Guarding	Rebound	Shock
Blunt	23 (82%)	6 (21%)	24 (86%)	21 (75%)	5 (8%)	7 (25%)
Stab	31 (42%)	2 (3%)	34 (46%)	11 (15%)	4 (5%)	20 (27%)
Firearm	22 (30%)	1 (2%)	39 (64%)	20 (33%)	4 (7%)	27 (44%)

Table 3. Laboratory findings.

Trauma	WBC ≥ 10,000	Amylase	X-ray abnormal	Other
Blunt	15/26	11/21	4/14	4/4 CT 4/4 UGI series 2/3 Lavage
Stab	36/69	2/28	5/20	1/1 CT
Firearm	23/52	4/19	1/27	None

WBC = white blood cell; CT = computed tomography; UGI = upper gastrointestinal.

pancreatic injury in the blunt group (5 pancreatic injuries apparent at surgery). Neither of the 2 abnormal amylase determinations in the stab group and 2 of 4 elevated levels in the firearm group accompanied pancreatic injuries. The majority of pancreatic injuries in the penetrating injuries had no rise in the amylase or no determination was obtained.

Free or retroperitoneal air, ileus, or the findings of intra-abdominal fluid constitute radiologic evidence for intra-abdominal injury. Lucas and Ledgerwood also used scoliosis on plain x-ray as a sign of abdominal injury [8]. Where reports were available, plain abdominal films were interpreted as positive for these findings in only 29% of blunt injuries, 25% of those x-rays obtained in stabbing victims, and only 4% of patients who had been shot. Many patients in the penetrating trauma groups did not have films or only had a flat plate. The confirmation of an intra-abdominal missile was not counted as a positive finding for bowel injury. This lack of utility of plain x-rays in diagnosing blunt or penetrating intestinal trauma agrees with several other studies [7, 8, 11, 15–17].

Peritoneal aspiration or lavage has been recommended as an accurate means of diagnosing both blunt [2, 7, 9, 11, 17, 18] and penetrating [12, 19, 20] trauma. Our usual policy is to perform peritoneal lavage only in those patients following blunt trauma with other major injuries requiring surgery, such as head injuries. Lavage was positive in 2 of the 3 patients in whom it was performed. It delayed operative treatment in the false-negative case, a patient with a transected duodenum, pancreatic

laceration, and avulsed common bile duct, who subsequently died of sepsis. All of our patients with stab wounds are locally explored (2 cases in this series) or taken for immediate laparotomy. All gunshot wounds felt likely to have passed through or near the peritoneal cavity are routinely explored.

Upper gastrointestinal (GI) series with water-soluble contrast medium were done in 4 patients after blunt injuries. All were positive, with 2 demonstrating a duodenal hematoma and the other 2 showing extravasation from duodenal perforations. We have previously reported our results in the diagnosis of blunt abdominal trauma using computed tomography (CT) [21]. Patients with a significant blow to the abdomen or altered mental status that does not require immediate operative treatment have a CT scan. In the 4 patients studied in this group, all had findings on CT scan indicative of bowel or intra-abdominal injury. One scan showed only thickening of the wall and narrowing of the lumen of the second portion of the duodenum, consistent with a duodenal hematoma. This was confirmed by upper GI series, and the patient was managed nonoperatively. The other 3 CT scans were performed in patients with bowel perforations without additional abdominal injuries. These included a hole in the duodenum, a jejunal laceration, and 4 small ileal perforations. In 2 of these scans, thickened bowel at or adjacent to the perforation was noted. Two CT scans showed free intra-abdominal fluid; the third scan was positive for pneumoperitoneum. Unfortunately, one scan with pelvic fluid only was misinterpreted and resulted in the delay of surgical treatment.

Operative Management

Fast transport from the scene of injury, efficient resuscitation, and evaluation of the patient are critical to the management of patients with intestinal trauma, but early recognition and surgery are essential to assure a favorable outcome. The majority of patients with penetrating injuries were undergoing surgical repair in less than 2 hours from the dispatch of an ambulance (Table 4). Patients with blunt injury were slower in arriving in the operating room, but there were more frequent delays in arrival at our facility. Nevertheless, 69% of these

Table 4. Time to surgery.

Trauma	<1 hour	1–2 hours	2–6 hours	>6 hours
Blunt	3 (12%)	3 (12%)	12 (46%)	8 (31%)
Stab	15 (20%)	29 (39%)	20 (27%)	10 (14%)
Firearm	19 (31%)	32 (52%)	8 (13%)	2 (3%)
Total	37 (23%)	64 (40%)	40 (25%)	20 (12%)

patients were operated on in less than 6 hours after the estimated time of injury or ambulance dispatch. In 10 cases in which an identifiable cause of delay was determinable, 5 were related to patient delay in seeking treatment or refusing surgery and the other 5 were the result of late diagnosis. Two of these patients died as a result of delay in treatment, 6 recovered from surgery without problem, and 2 did not undergo surgery. Time periods of more than 6 hours between injury and surgery in the 2 penetrating trauma groups were all the result of patient delay.

Table 5 shows the distribution of injuries by anatomic location and by mechanism of injury. Small bowel injuries were those that were not specified as jejunum or ileum in the operative report. Multiple injuries to the same segment of intestine were only counted once, while injuries to distinct regions of intestine (e.g., jejunum and ileum) were both noted. A preponderance of duodenal and proximal jejunal injuries was seen with blunt trauma. The jejunum was the most frequently injured portion of small bowel in the patients with penetrating wounds. Duodenal trauma was more common with firearm than with stabbing wounds. The frequency of multiple segments of small bowel injured increased from blunt to penetrating groups, with 26% of those shot having more than one area of intestine injured.

A penetrating missile or knife usually creates an even number of holes in a hollow viscus, while perforations from blunt injuries are commonly single. Table 6 shows the number of intestinal holes made by the different types of trauma. This series included a number of injuries that did not enter the lumen of the bowel. These lesions were most often seen with blunt trauma and included hematomas (one of which resulted in an intussusception), ischemia of the bowel due to mesenteric injury, seromuscular tears, and contusions. Of the 20 seromuscular injuries in the stab wound group, 15 were isolated injuries and 5 occurred with additional full-thickness injury of the bowel. The majority of these partial-thickness lesions were closed with interrupted silk Lembert sutures. Of those patients having several holes in the bowel, 15 had no definite number stated in the operative record. Excluding these patients and those without luminal penetra-

tion, there were an average of 1.3 holes in the blunt group, 3.2 perforations in the stabbed patients, and 5.1 holes in the firearms category.

Other abdominal injuries are commonplace in cases of intestinal trauma from either blunt or penetrating causes [6, 7, 15, 22]. Associated intra-abdominal lesions are recorded in Table 7. Although multiple colon wounds may have occurred in both right and left colon in the same patient, multiple wounds were only counted as one. Mesenteric injuries were only tabulated if distinct from a point of injury to the bowel. Intra-abdominal vascular injuries were recorded individually, with several cases of more than one vessel damaged in the same patient. Table 7 also depicts the concurrent injuries outside of the abdomen. Chest injuries included diaphragmatic lacerations and perforations. The orthopedic and extremity category encompassed pelvic fractures and soft tissue and skeletal wounds of the limbs. There was a general increasing trend in injury frequency from the blunt to the penetrating trauma groups, but no real pattern emerged.

Table 8 lists the types of repairs used for the intestinal injuries in this series. There was no repair of 4 duodenal hematomas, a partial-thickness jejunal laceration, and a small bowel contusion in the blunt trauma group; no repair was needed for an eviscerated loop of bowel without perforation in the stab group; and no repair was required in 2 patients with intestinal injuries who died intraoperatively of gunshot wounds. Duodenal injuries showed the most variability of repair, largely depending on the mechanism of injury. The majority of blunt duodenal injuries requiring repair (70%) were fixed with a complex procedure. Pyloric exclusion using surgical staples, as described by Vaughan and others [23], was used in 5 cases; duodenal diverticulization, initially described by Berne and associates [24], and pancreaticoduodenectomy were each performed once. The remaining 3 duodenal perforations were closed primarily. In contrast, 94% of stab wounds of the duodenum were closed by simple repair and only 1 complex repair (pyloric exclusion) was done. Of the 18 duodenal gunshot injuries, 2 were not repaired because of intraoperative death, 6 (38%) were closed primarily, 2 (12%) were closed after partial duodenal resection, and 8 (50%) underwent complex repair (6 pyloric exclusions, 1 diverticulization, and 1 pancreaticoduodenectomy). Blunt and firearm trauma to the remainder of the small intestines were repaired in approximately equal numbers of primary closure and resection. The vast majority of stab wounds of the jejunum and ileum, however, were treated by simple oversewing.

Table 5. Location of injury.

Type	Duodenum	Jejunum	Small Bowel	Ileum	Multiple
Blunt	14 (50%)	12 (43%)	2 (7%)	4 (14%)	4 (14%)
Stab	13 (18%)	39 (53%)	9 (12%)	7 (9%)	13 (18%)
Firearm	18 (30%)	27 (44%)	18 (30%)	16 (26%)	16 (26%)
Total	45 (25%)	78 (44%)	29 (16%)	27 (15%)	33 (20%)

Table 6. Number of bowel perforations.

Trauma	None	1	2	3	4	5	6	7–10	>10	Multiple
Blunt	15[a]	15	2	–	1	–	–	–	–	–
Stab	20[b]	6	22	3	13	7	3	2	0	3
Firearm	2	5	14	1	9	1	7	4	6	12

[a] These blunt injuries included 8 hematomas, 4 seromuscular lacerations, 2 ischemic bowel segments due to mesenteric tears, and 1 contusion.
[b] Five had concurrent perforations, 15 were isolated seromuscular lacerations.

Table 7. Associated injuries.

	Blunt	Stab	Firearm
Intra-abdominal			
Colon	3	17	24
Vascular[a]	1	14	34
Mesentery	6	18	11
Liver	3	4	13
Stomach	1	7	11
Pancreas	5	3	7
Urinary tract	1	3	8
Retroperitoneum	3	4	4
Biliary tree	1	2	4
Spleen	3	0	0
Other sites			
Chest	5	17	8
Orthopedic/extremity	6	9	12
Head and neck	6	8	3
Spinal cord	0	0	5

[a] Multiple vascular injuries in several patients.

Table 8. Type of intestinal repair.

Repair	Blunt	Stab	Firearm
None	6	1	2
Simple closure			
Duodenum	3	15	6
Jejunum	5	51	11
Small bowel	1	9	9
Ileum	2	9	11
Resection			
Duodenum	0	0	2
Jejunum	5	5	16
Small bowel	0	1	11
Ileum	2	1	13
Complex	7	1	8

Outcome

There were 11 deaths among the 163 patients reviewed (7% mortality) (Table 9). There was a 21% mortality rate in the blunt trauma group, compared to 6% in patients who had been shot and 1% in patients who had been stabbed. Of note was that 5 of the 6 deaths in the blunt trauma group and 2 of the 4 deaths from gunshot wounds included duodenal injuries. This was an overall mortality of almost 18% for duodenal injuries.

All 3 of the deaths due to sepsis in the blunt trauma category involved duodenal injuries and delays in treatment, 1 because of patient presentation 2 days after an assault (died 1 day after pyloric exclusion) and 2 because of diagnostic delays. The first of these last 2 patients was not explored until 18 hours after his motor vehicle accident. He died 16 days following pyloric exclusion of multiorgan failure and sepsis with intra-abdominal abscesses. The other patient was not explored until more than 10 hours after a combined duodenal, pancreatic, and biliary injury. He underwent pancreaticoduodenectomy and died of a necrotizing retroperitoneal infection 3 days later. Delay in treatment was due in part to a false-negative peritoneal lavage.

Five of the 11 deaths were related to uncontrolled hemorrhage. Two patients died intraoperatively, 1 from a bullet wound to the right iliac artery and vein, the other from irreparable damage to her mid-abdomen from a self-inflicted shotgun blast. An 85-year-old woman died shortly after surgery for massive blunt injury from a car which struck her while she ate in a restaurant. The last 3 deaths occurred in the first 3 postoperative days as the result of multiple organ failure and disseminated intravascular coagulopathy. The final 2 deaths were the result of anoxic brain damage. This occurred after a 4-story fall in 1 patient and the other was

Table 9. Mortality rate and cause of death.

Type of trauma	Number		Cause of death
Blunt	3		Sepsis
	2		Anoxic brain death
	1		Hemorrhage
Subtotal	6	(21%)	
Stab	1	(1%)	Multiple organ failure
Firearm	3		Hemorrhage
	1		Multiple organ failure
Subtotal	4	(6%)	
Total	11	(7%)	

Table 10. Complications.

Complication	Blunt	Stab	Firearm
Infection			
Wound	1	3	2
Intra-abdominal	0	1	5
Respiratory	1	1	1
Catheter related[a]	2	1	1
Total	4	6	9
Ileus/bowel obstruction	1	5	5
Hemorrhage	1	3	2
Iatrogenic			
Venous thrombosis	1	1	1
Splenic laceration	2	0	0
Arterial injury	0	1	0
Fistulas	0	0	2
Miscellaneous	1	1	4
Total	10 (9 pt)	17 (16 pt)	23 (19 pt)
Complication rate	41%	22%	33%

[a]Includes 2 documented urinary tract infections, 1 line sepsis, and 1 septic phlebitis.

struck by a car. Both patients presented in shock, and 1 required emergency thoracotomy for resuscitation.

The complication rate was highest for patients suffering blunt trauma (41%), with rates of 33% and 22% in stab and gunshot wound groups, respectively (Table 10). Complications occurred in 30% of all patients surviving their injuries. Infectious complications were the most frequent. Most patients received between 2 ad 5 days of perioperative antibiotic coverage, usually consisting of a broad-spectrum cephalosporin (cefoxitin) or a combination of an antibiotic effective against anaerobes (penicillin, clindamycin, or metronidazole) and an aminoglycoside (kanamycin, gentamicin, or tobramycin). All 6 wound infections were cases in which the wound had been closed primarily with Steristrips®. Five of these injuries involved duodenum or jejunum only, segments of the bowel known to have low bacterial counts [25]. The 1 wound infection that involved more distal bowel included both right and left colon injuries and led to wound dehiscence. Abdomens contaminated by chyme or stool were routinely irrigated with several liters of normal saline, usually with the last liter containing bacitracin and kanamycin. Of the 6 intra-abdominal infections that developed postoperatively, 5 occurred in patients who sustained colonic perforations. Three were drained operatively, 3 by percutaneous routes. Only 1 case of pneumonia developed in each group, although the incidence of atelectasis and postoperative pulmonary fevers was much higher. The remainder of the infectious complications were the result of urinary drainage and peripheral or central intravenous catheters.

Postoperative bowel motility problems were the next most common difficulty. There were 6 cases of prolonged adynamic ileus and 5 mechanical bowel obstructions, 3 of which were returned to surgery (recurrent duodenal hematoma drained, lysis of adhesions causing bowel torsion, and lysis of adhesions causing efferent loop obstruction). Of the 6 patients who were reexplored for hemorrhage, 1

had diffuse oozing and the other 5 definitive sites (kidney in 2, pancreas in 2, and duodenum in 1). Two of these patients eventually died.

There were a number of iatrogenic complications. Three central venous thomboses (1 in each category) resulted from catheters used for hyperalimentation or monitoring filling pressures. A brachial artery injury occurred during placement of a venous cutdown and was successfully repaired. Two iatrogenic splenic lacerations were recorded, neither of which required splenectomy. A 2–3-mm perforation of the third portion of the duodenum was missed on initial exploration of an abdominal gunshot wound. This patient was reoperated on 2 days later, and Berne diverticulization was performed. His subsequent recovery was unremarkable.

Of particular note in this series was the infrequent occurrence of fistulas following duodenal injuries. The only pancreatic fistula developed in a patient treated by duodenal diverticulization for a gunshot wound that shattered the distal stomach and first portion of the duodenum with a "superficial" laceration of the pancreas. This complication probably represented underestimation of the pancreatic injury. This pancreaticocutaneous fistula was still open 4 months after injury, when the patient was last seen. A biliary cutaneous fistula occurred in a man shot 3 times in the abdomen with his injuries including a through and through laceration of the right lobe of the liver and a "superficial" wound of the pancreas, but no duodenal damage. This fistula probably was the result of drainage from disrupted intrahepatic biliary radicles, but could have been due to underestimation of the pancreatic laceration or an unrecognized duodenal or bile duct injury.

This fistula also was open at the last time the patient was seen, 10 months after his shooting.

Thirty percent of the surviving patients were not seen again after discharge from the hospital, due mostly to failure to keep clinic appointments, but also because of the transfer of care to other facilities once stable. Only 41% of the patients seen at our institution after discharge were treated at some point more than 1 year later. The remaining 59% of patients were followed for less time (28% of the total group for less than 6 months, 14% of all survivors for between 6 and 12 months). No late morbidity or mortality, except as noted above, was recorded in these follow-up periods, although complication rates would probably have been higher with more complete long-term care.

Discussion

The patient population of our series is typical for reviews of trauma in general, with the average patient being a man in his third or fourth decade. Penetrating intestinal injuries usually predominate over those caused by blunt trauma [7, 18, 22, 26]. Only 17% of our patients suffered blunt injuries, 68% of these related to motor vehicle accidents. Stab wounds were more common than firearm injuries in our study, in part due to the inclusion of seromuscular lacerations.

The diagnosis of blunt intestinal injuries presents a difficult diagnostic problem in the absence of shock or signs of peritoneal irritation. Because of the neutral pH of the succus entericus [2], the low bacterial counts in the normal small intestine [25, 27], and the retroperitoneal location of part of the duodenum [28], physical signs may not be present when the patient is initially examined. Delay in diagnosis, especially in the duodenal injury with spillage of bile and activated pancreatic enzymes, results in increased morbidity and mortality [2–4, 6–8, 14, 29]. Conventional laboratory tests, including white blood cells, serum amylase, and abdominal x-rays, have proven unreliable in detecting most blunt intestinal injuries in repeated trials [2, 6–15]. Peritoneal lavage has improved the rate of detection of bowel injuries after blunt trauma, with positive results in 70–95% of cases [9, 11, 17, 18]. Although not enough CT scans were done in this series to determine the accuracy of diagnosing intestinal injuries (several additional intestinal injuries have been diagnosed on emergency CT scans since this review), it may prove of use in this area. The CT scan has the benefits of being noninvasive and capable of viewing the entire abdomen and lower chest and finding other unsuspected conditions. No laboratory test or study is likely to supplant clinical suspicion and acumen in detecting blunt intestinal injuries. Patients must be observed closely and explored early when signs and symptoms of intra-abdominal injury exist.

There has been debate about the need to explore all penetrating injuries to the abdomen [10, 12–14, 20, 30, 31]. Our policy has been a conservative one, relying on wound exploration or immediate laparotomy for stab wounds of the abdomen and laparotomy for all bullet wound felt to pass near the peritoneal cavity. This method of treatment has result in minimal morbidity from negative laparotomies and avoided delayed diagnosis in penetrating wounds.

The operative management of wounds to the jejunum and ileum is usually straightforward, regardless of the mechanism of injury. Simple lacerations are closed primarily, complex or multiple injuries are resected, and ischemic bowel is debrided or resected. The majority of stab wounds of the intestine can be closed in 1 or 2 layers, whereas bullet and blunt injuries are more often resected owing to greater tissue injury.

Repair of duodenal injuries requires much greater skill and surgical judgment. Simple lacerations can be closed primarily; however, any leak from the repair can be catastrophic. Complex injuries usually require resection, serosal patching, end-to-side anastomosis, or diversion of biliary injuries further complicate the repair of the damaged duodenum. Our preferred technique of repair for major duodenal injuries was diversion by pyloric exclusion [23] using staples to close the duodenum and a tube duodenostomy. A modified Berne diverticulization [24] was needed only twice when the first portion of the duodenum was damaged beyond repair. We do not routinely drain the common duct. These operations both substitute a potential end duodenal fistula for the lateral fistula that would result without diversion of gastric chyme. Frequent reliance on these procedures may explain the absence of duodenal fistulas in this series. Pancreaticoduodenectomy was utilized only twice, once for combined injuries of the duodenum, pancreas, and distal common bile duct and one for combined duodenal and pancreatic head injury. This procedure is to be reserved for the combined organ injury, not repairable by simpler means [32, 33].

Since blunt injuries usually result from more force being imparted to the victim [5], with resultant multiple injuries, it is not surprising that deaths and complications are higher in this category. Energy sufficient to crush intestine against the spine, shear the bowel wall, or burst the intestine by suddenly increasing intraluminal pressure results in multiple, serious intra-abdominal injuries [2]. The death rate of 21% in patients with blunt trauma is comparable to other series in the literature [2, 15, 16, 34]. The

blunt duodenal injury is particularly deadly, with a mortality rate of 36% in our patients and a range of 11 to 26% in the literature [7, 35–39]. Our higher mortality was the result of delayed treatment (3 deaths) and coincidental duodenal hematomas in patients who died of other causes (2 deaths), coupled with a small total number (14) of blunt duodenal injuries.

Infectious complications were the most common in this study. Closure of the contaminated wound after abdominal trauma can be done in the majority of patients, if colon has not been perforated. Even with 5 days of perioperative antibiotics, small bowel perforations result in a 9% wound infection when closed primarily [40]. With contamination, we prefer to close abdominal skin and subcutaneous wounds by delayed primary closure. Colon injuries not unexpectedly occurred with most of the intra-abdominal infections. Iatrogenic infections involving catheters accounted for a substantial percentage of the infectious complications. Strict attention to aseptic technique should be maintained by all staff members. Intravenous lines inserted while the patient is in the emergency room are removed in the next 24 hours owing to the likelihood of contamination.

In conclusion, traumatic injuries of the duodenum and small intestine require expeditious evaluation and treatment, especially in the case of blunt trauma, where lack of finding may lead to delays in diagnosis. Blunt injuries without definite signs of intraperitoneal injury should be aggressively worked up and followed closely with serial examinations and laboratory work. Penetrating injuries suspected of entering the abdominal cavity should be explored as soon as possible. Intestinal injuries can be repaired simply by closure or resection. Dudodenal injuries must be approached individually, with diversion of gastric contents if the duodenal closure seems insecure. Perioperative antibiotic coverage and reliance on delayed primary closure for grossly contaminated wounds will lower the rate of infectious complications, as will proper care of lines and catheters. Expeditious treatment and appropriate perioperative management should lessen death and complications from this common form of trauma.

Résumé

Cent soixante-trois blessés ont été traités pour des contusions ou des plaies du duodénum et de l'intestin grêle dans un centre de traumatologie au cours d'une période de 4 ans et demi. Les contusions, le plus souvent secondaires à un accident de transport représentent 17% des cas par rapport aux plaies par armes blanches et par armes à feu. L'exploration biologique comprenant la numération globulaire et le dosage de l'amylase ainsi que l'exploration radiologique de l'abdomen sont insuffisantes pour reconnaitre l'existence d'une lésion intestinale. En revanche la tomodensitométrie qui a été possible chez quelques blessés permet d'explorer le contenu intra-péritonéal et de porter le diagnostic de lésion gastro-intestinale. Le traitement d'urgence de ces blessés est indispensable: 63% d'entre eux ont été opérés moins de 2 heures après le début du traitement médical. Les lésions dans leur majorité peuvent être traitées par simple suture ou par résection. En raison de considérations anatomiques et physiologiques particulières des méthodes opératoires complexes sont nécessaires pour traiter certaines lésions duodénales. L'attitude qui a été adoptée a consisté souvent en l'exclusion du pylore et aussi en la diverticulisation du duodénum ou en la duodénopancréatectomie. Le retard dans le traitement, l'importance et le nombre des lésions associées contribuent à accroitre la morbidité et la mortalité qui est plus importante pour les contusions que pour les plaies (21% contre 4%); en particulier quand le duodénum est intéressé (36%). Les complications sont également plus nombreuses après les contusions et les lésions multiples. Les complications infectieuses sont les plus fréquentes avec l'iléus paralytique et l'occlusion, l'hémorragie et les complications iatrogèniques sont les plus rares. Dans la majorité des lésions du grêle le traitement doit être entrepris directement et sans aucun retard. La crainte de l'existence d'une lésion et la confiance dans l'exploration tomodensitométrique permettent de porter le diagnostic précoce des lésions occultes du grêle. Un jugement chirurgical sain et la possession de techniques chirurgicales variées est nécessaire pour traiter les lésions duodénales complexes.

Resumen

Ciento sesenta y tres pacientes fueron tratados por trauma cerrado o penetrante del duodeno o del intestino delgado en el curso de un período de cuatro y medio años en un centro de trauma mayor. Las lesiones por trauma cerrado, principalmente como resultado de accidentes automoviliarios, comprendieron el 17% de los casos y el resto estuvo constituído por lesiones cortopunzantes y por armas de fuego. Los exámenes de laboratorio, incluyendo el recuento globular blanco y la amilasa, y las radiografías de abdomen, fueron poco confiables en cuanto a la predicción de la presencia de una lesión intestinal. Aun cuando sólo fue realizada en unos pocos pacientes con trauma cerrado, la tomografía computadorizada del abdomen apareció sensible a hallazgos intraperitoneales

sugestivos a diagnósticos de lesión gastrointestinal. El tratamiento quirúrgico rápido de estos pacientes es de la mayor importancia; 63% de ellos fueron operados en menos de 2 horas a partir de la iniciación del tratamiento médico. La mayoría de las lesiones intestinales puede ser corregida mediante simple sutura o resección. Debido a consideraciones anatómicas y fisiológicas, procedimientos quirúrgicos complejos son requeridos para la corrección de algunas lesiones duodenales. Nuestra forma de tratar tales lesiones incluyó la utilización frecuente de la exclusión pilórica, así como la ocasional diverticulización del duodeno y la pancreatoduodenectomía. La demora en el tratamiento quirúrgico y la magnitud y número de las lesiones asociadas contribuyeron a acrecentar la morbilidad y la mortalidad, las cuales fueron bastante mayores en el trauma cerrado (21% versus 4% para las lesiones penetrantes), especialmente cuando el duodeno estaba involucrado (mortalidad de 36%). Las complicaciones tambien fueron más frecuentes en los pacientes con trauma cerrado y con múltiples lesiones. Las complicaciones sépticas fueron las más frecuentes, mientras el íleo o la obstrucción, la hemorragia y las complicaciones iatrogénicas se presentaron con menos frecuencia. En la mayoría de las lesiones del intestino delgado el manejo es bastante claro y consiste en la reparación quirúrgica, tan pronto como sea posible. Un alto índice de sospecha y el uso de métodos de diagnóstico, tales como la tomografía computadorizada, aceleran el diagnóstico de lesiones intestinales cerradas y ocultas. Un buen juicio quirúrgico y la capacidad de emprender una variedad de tipos de reparaciones quirúrgicas son necesarios en el tratamiento de lesiones duodenales complejas.

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