

Duodenal Injury

Analysis of Common Misconceptions in Diagnosis and Treatment

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Seventy-five consecutive patients who sustained injuries to the duodenum were admitted to our hospital over a nine-year period. Nineteen blunt injuries and 56 penetrating injuries were encountered. Blunt injuries were usually the result of motor vehicle accidents and steering wheel impact was frequently implicated. Penetrating injuries most commonly followed gunshot wounds, particularly those where the bullet tract travelled transversely across the peritoneal cavity. Seventy-nine per cent of the patients had two or more associated intra-abdominal organ injuries with other intestinal injuries, biliary tract injuries, and pancreatic injuries predominating. Forty-seven per cent of the patients were admitted in shock. Following blunt injury, diagnostic delay was encountered in two patients. Adjuncts to diagnosis such as abdominal roentgenograms, serum amylase levels, and contrast gastro-duodenography, were not helpful. Peritoneal lavage, however, was valuable in patients with equivocal physical findings. Intraoperative diagnosis was also challenging. Complete mobilization of the structures surrounding the duodenum to provide exposure of the entire duodenum was necessary. Six injuries that initially appeared trivial would have been missed had this procedure not been followed. Suture closure was the most common reparative technique used. Tube decompression of the duodenum was a valuable addition. No suture line dehiscences were encountered in ten patients so treated. Overall mortality in patients surviving more than 24 hours was 12%.

DUODENAL INJURY FOLLOWING blunt or penetrating trauma remains one of the most challenging problems confronting the trauma surgeon. Lacerations of the duodenal wall due either to penetrating or blunt trauma, result in leakage of bowel content which when combined with bacterial contamination in the areolar tissues of the posterior retroperitoneum makes repair difficult. Associated pancreatic or biliary injury adds to the chemical peritonitis. Significant delay in the control of contamination greatly enhances the likelihood of septic complications and anastomotic disruption.

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Penetrating injuries to the duodenum are most often the result of gunshot wounds to the abdomen, particularly those in which the bullet tract follows a transverse direction across the peritoneal cavity. Since exploratory laparotomy is routinely employed in such patients, delay in diagnosis is not usually a factor influencing subsequent complications. However, the signs of duodenal injury following blunt trauma are often subtle.³ Likewise, diagnostic maneuvers such as peritoneal lavage, which generally carry a low false-negative rate, are not thought to be as accurate in cases of retroperitoneal bleeding.¹ These factors have combined to make delayed recognition a significant problem in patients with blunt duodenal injury.

When duodenal laceration is confirmed, the surgeon must choose an appropriate method of repair. The fact that a wide variety of treatment options have been described indicates a lack of satisfaction with any one technique for managing the spectrum of injuries encountered. Following repair the surgeon may elect some form of duodenal decompression.

Miller,⁹ in 1916, cited a mortality rate of 90% for duodenal injuries and emphasized delayed operation and technical factors as major obstacles to survival. Although recent reviews^{6,8} document a mortality reduced to 15% or less, delayed treatment and technical failures continue to contribute to death and disability for these patients.

This study details the recent experience of an active trauma unit with duodenal trauma.

Materials and Methods

Seventy-five consecutive patients sustaining duodenal injury were admitted to University Hospital/

TABLE 1. *Duodenal Injury*

Men	66
Women	9
Blunt injury	19
Penetrating injury	56

Louisville General during the nine-year period following January 1, 1970. Sixty-six men and nine women were observed. The youngest was 13 years of age and the oldest seventy-five (mean: 31 years). Fifty-six patients (77%) sustained penetrating injuries, while blunt trauma caused 19 injuries (23%). Demographic characteristics of the cohort of patients are depicted in Table 1. Each was managed according to the following treatment protocol.

Management of Patients with Suspected Duodenal Injury

Injured patients are admitted to a specifically designated area of the operating room and resuscitation is begun. After assurance of an airway and institution of measures to restore lost intravascular volume, a complete physical examination is undertaken. Penetrating injuries of the abdominal wall are managed selectively. Stab wounds, suspected to enter the peritoneal cavity but without physical signs of peritoneal irritation are locally explored under Lidocaine infiltration anesthesia. Documentation of deep penetration indicates exploratory laparotomy as do gunshots in proximity to the peritoneal cavity.

When patients are suspected to have duodenal injuries as a result of blunt trauma, the decision to undertake exploratory laparotomy is made on the basis of physical findings in patients who are alert and able to cooperate in their physical examination. When the physical examination is unreliable, peritoneal lavage is performed using standard techniques. Discovery of significant volumes of blood in the peritoneal cavity dictates the need for exploratory laparotomy.

The patient who is at risk for duodenal injury and who has a negative peritoneal lavage or equivocal physical findings is observed. Adjunctive methods of diagnosis, such as upright abdominal or chest roentgenograms looking for free intraperitoneal or retroperitoneal air, serial observations of serum amylase levels, and upper gastrointestinal contrast studies have been employed to facilitate diagnosis of duodenal injury.

Operative Management of Patients with Duodenal Injury

Preoperative broad-spectrum antibiotics are administered intravenously. A long, midline laparotomy incision is routinely used. A thorough search for intra-

peritoneal injuries is followed by division of the lateral attachments of the duodenum and the incision in the posterior parieties is extended from the foramen of Winslow around the duodenal C-loop to the junction of the third and fourth portion of the duodenum. The retroperitoneum is separated from the pancreas and the pancreaticoduodenal complex is elevated until the anterior surface of the aorta is clearly visible. The fourth portion of the duodenum as it passes under the superior mesenteric artery is exposed by elevating the posterior parietal attachments of the cecum and small intestine from lower right to upper left along the embryologic fusion line as described by Cattell and Brasch.²

The injury is visualized and repaired according to the surgeon's assessment of severity of injury, the involvement of associated organs such as the pancreas or biliary tract, and the general condition of the patient. Suture closure of transmural injuries, using two layer technique is preferred. Obviously devitalized tissue is debrided and closure affected transversely, parallel to the circumferential blood vessels supplying the duodenal wall. Stenosis of the lumen is minimized. Large defects in the duodenal wall are particularly hazardous. When direct suture is not technically feasible, a Roux-en-Y duodenojejunostomy may easily cover such defects and allow construction of suture lines in well-vascularized tissue under minimum tension. Injuries to the fourth portion of the duodenum may be managed with conservative duodenectomy and direct duodenojejunostomy. Duodenal resection, diverticulization and pancreaticoduodenectomy are reserved for severe crushing injuries involving pancreas, duodenum and biliary tract.

Suction drainage of the periduodenal area is indicated for most injuries. Tube gastrostomy, duodenostomy and feeding jejunostomy have recently been added for all lacerations exceeding 20% of the duodenal circumference.

Peroral nutrition is prohibited until contrast studies performed two to three weeks after injury demonstrate a secure suture line without obstruction.

Results

Mode of Injury

Modes of injury are listed in Table 2. Blunt injuries are commonly the result of direct compression of the upper abdomen. Of the 13 motor vehicle accidents which caused duodenal injury, deceleration injury with compression of the epigastrium could be documented in ten instances. Steering wheel impact occurred in seven patients. Gunshot wounds dominated as the cause of penetrating duodenal wounds.

TABLE 2. *Mode of Injury*

Mode of Injury	Number of Patients
Blunt	
motor vehicle	13
direct blow or crush	3
miscellaneous	3
Penetrating	
gunshot wound	51
stab	4
miscellaneous	1

Location of Injury

The distribution of injuries for patients sustaining blunt and penetrating trauma are listed in Table 3. After penetrating trauma, injuries were evenly distributed throughout the anatomic course of the duodenum. However, blunt trauma caused injury to the second portion of the duodenum in the majority of patients with the posterior surface of the duodenum being the most frequent site of perforation.

Classification of Injury

Injuries were classified according to severity as follows: 1) *hematomas and contusions* not requiring repair, 2) *perforations* involving less than 20% of the luminal circumference; 3) *lacerations* involving more than 20% but less than 70% of luminal circumference; and 4) *disruptions* involving more than 70% of luminal circumference. Patients are divided according to type of injury in Table 4.

Associated Injuries

Isolated duodenal injury was uncommon. The most frequently observed associated injuries are listed in Table 5. Adjacent hollow visci were frequently lacerated, giving rise to severe intraperitoneal and retroperitoneal contamination. Seventy-nine per cent of our patients had two or more associated intra-abdominal injuries. Hemorrhagic shock, defined as systolic arterial pressure of 80 mmHg or less on admission or clinical signs of shock, was present in 47% of patients. Ethanol abuse was implicated in 19 of 75 patients (26%).

TABLE 3. *Location of Injury*

	Portion				Multiple
	1st	2nd	3rd	4th	
Penetrating	7	12	7	13	16
Blunt	2	6	1	3	5

TABLE 4. *Types of Injury*

	Blunt	Penetrating
Hematoma	5	6
Perforation	1	26
Laceration	4	22
Disruption	9	2

Diagnosis of Duodenal Injury

Physical signs of blunt duodenal injury are subtle. Abdominal tenderness and evidence of peritoneal irritation were most frequent indications for laparotomy in patients who were conscious on admission (7 of 19 patients). Unconscious patients and those with equivocal findings had peritoneal lavage which led to exploration of ten patients. Delay in diagnosis was encountered in two patients. In one of these, peritoneal lavage was not performed until 12 hours after admission, but was positive at that point. A second patient admitted after a beating developed positive physical findings 14 hours after admission. In retrospect, an altered state of consciousness on admission should have led to an early peritoneal lavage in this instance. Both patients died.

Serum amylase levels rarely indicated duodenal injury. Twenty-six determinations were done in patients with proven injuries and only three were elevated. Similarly, free intraperitoneal or retroperitoneal air was rarely observed. Sixty-two patients had abdominal and chest roentgenograms performed with upright views; in only three was air visible. Contrast gastroduodenography was employed in three patients; one study was positive for injury.

All patients with evidence of peritoneal penetration were explored. Diagnostic delay was not encountered in patients with penetrating injuries.

Intraoperative diagnostic findings were frequently equivocal. Obvious periduodenal hematoma, bile staining, or retroperitoneal gas were absent in six of 19 patients explored for blunt injury, and transluminal lacerations requiring repair would have been missed in each of these patients had our policy of complete exposure of the duodenum not been followed.

TABLE 5. *Associated Injuries*

Liver	31
Colon	29
Small intestine	25
Stomach	24
Pancreas	20
Vena cava	13
Kidney	12
Biliary tract	11

TABLE 6. Duodenal Injury

Causes of Death	No. Patients*
Exsanguination	5
Sepsis	10
Pulmonary embolus	1
Hepatic necrosis	1

* More than one cause in three patients.

Mortality

Fourteen of 75 patients died for an overall mortality of 19%. Five patients died less than 24 hours after admission due to hemorrhagic shock or massive associated injuries. Causes of death are listed in Table 6.

Associated injury influenced mortality significantly. As the number of additional intra-abdominal organs injured rose, mortality increased. Ten of 27 patients (37%) having four or more additional organ injuries died while only six of 44 (14%) with fewer than four organs involved died. Blunt injuries resulted in a 11% mortality while 20% of patients with penetrating injuries died. Overall mortality for patients surviving more than 24 hours was 12%.

Reparative techniques were analyzed to assess influences on mortality and morbidity (Table 7). Suture repair was possible in 45 patients. Six patients had suture-line dehiscence and resulting sepsis. Four of these patients died. Suture lines were buttressed with jejunal serosal patches in five additional patients. One nonfatal anastomotic leak occurred. Duodenojejunostomy was performed after segmental duodenectomy in three patients and once a Roux-en-Y limb to cover a laceration. No suture line leaks were observed in these patients. One death resulted from renal failure. Isolation-drainage (diverticulization) and Whipple resections were used infrequently.

The influences of specific measures to decompress the duodenal suture line were assessed retrospectively. Duodenal decompression was used in ten patients and most frequently was obtained by long tubes passed transnasally or transgastrically through the pylorus (6 patients). Foley catheter duodenostomy and decompressing jejunostomy were used in two patients each. Decompression was only used for lacerations involving more than 20% of the luminal circumference. No suture-line leaks were encountered in ten decompressed patients. Twenty-three patients with similar lacerations were not decompressed. Seven leaks were observed (30%), and four of the seven died.

Discussion

Improved outcome for patients with duodenal injury awaits advances in injury prevention, diagnosis and re-

parative techniques. Blunt duodenal injury follows upper abdominal compression with "blow-out" of the duodenum resulting from acute close-loop obstruction. Vehicular accidents account for the majority of blunt injuries. Steering wheel impact is commonly implicated. Six of 13 automobile accident victims in our series were drivers. None was wearing a seat belt.

Duodenal contents cause a spreading, severe inflammatory response in adjacent tissues; delay in repair leads to an increased incidence of bacterial contamination and the need to perform suture repair in edematous tissue. In this series, all 17 patients operated on within 12 hours after blunt injury survived whereas two patients who underwent delayed operation died. Corley and associates⁴ have observed similar results and have suggested that frequent physical examinations will lead to early diagnosis. These authors suggest that personnel specifically trained to perform frequent examinations may be obtained through formation of trauma teams. In our patients, peritoneal lavage was particularly helpful. Liberalization of indications for the use of their technique in conscious patients with equivocal physical findings should lead to improved diagnostic accuracy. Our observations indicate that roentgenographic examinations searching for free air and blood chemistry studies, particularly serum amylase level, are so infrequently positive that they are useless. These data confirm the findings of Talbott and Shuck¹¹ and Davis and associates⁵ regarding such adjuncts. We have had little experience with contrast gastroduodenography. Examinations were performed in three patients who were later proved to have duodenal lacerations and two were negative.

Intraoperative diagnosis was facilitated through the use of extended exposure of the duodenum. The wide Kocher maneuver and exposure of the fourth portion of the duodenum are essential elements of operative management. Six of our patients were thought to have trivial injuries until exposure disclosed significant lacerations transgressing the full thickness of the duodenum wall.

The frequency of associated injuries, particularly to other portions of the gastrointestinal tract and to the

TABLE 7. Duodenal Injury

Types of Repair	No.	Deaths	Anastomotic Leaks
Suture	45	5	6
Serosal patch	5	1	1
Duodenojejunostomy	4	1	0
direct	3		
Roux-en-Y	1		
Anastomosis	2	0	0
Isolation-drainage	2	1	0
Pancreaticoduodenectomy	3	1	0

pancreas, insures that heavy bacterial contamination and prolonged intraperitoneal and retroperitoneal inflammation will be encountered. Vigorous resuscitation of the patient in shock with blood, blood components, and balanced salt solutions is essential to the early management of duodenal injury. Preoperative broad-spectrum intravenous antibiotics are begun and continued for 72 hours. Repair of duodenal injuries is usually possible with suture closure. Whipple resection, serosal patch, or isolation-drainage are infrequently required. We encountered 20 patients with combined pancreaticoduodenal injury and found pancreaticoduodenectomy to be required in only three patients. Nevertheless, these techniques will occasionally be required and the surgeon should be prepared to use them in situations of combined crushing injuries of the pancreas, duodenum and terminal biliary tract. Time-honored principles of adequate blood supply, tension free suture lines and avoidance of distal obstruction are critical to successful duodenal repair.

Our data support the addition of duodenal decompression to the suture repair of duodenal lacerations as suggested by Stone and Fabian.¹⁰ A double jejunostomy tube arranged to provide duodenal compression as well as enteral feedings has merit. Foley catheter duodenostomy as described by Jones and associates⁷ also provides excellent duodenal decompression.

Postoperatively, signs of sepsis and organ failure in

the postoperative period indicate the need for reoperation, debridement and drainage. Nutritional support is frequently indicated following duodenal injury, and oral alimentation is proscribed until contrast studies two to three weeks after injury disclose an intact repair and normal duodenal transit.

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DISCUSSION

DR. GEORGE L. JORDAN, JR. (Houston, Texas): I was fascinated with Dr. Stone's experience. It differs somewhat from our own, however. We also treat abdominal trauma in Houston, and I would like to agree and emphasize his comments about exposure of the duodenum. The entire duodenum must be exposed. He has described one way, certainly, which accomplished this objective satisfactorily.

We have usually done a more limited Kocher maneuver, taken down the hepatic flexure, but have, in addition, divided the ligament of Treitz to carefully expose the fourth portion of the duodenum from the other side. In this way one rarely misses an injury.

Some years ago, we reviewed 131 consecutive patients with duodenal trauma. The fistula incidence was 6%. We used no particular protective mechanisms in that series. At that time I became interested in the duodenal exclusion procedures. Since then, in the severe injuries, we have used a duodenal exclusion procedure which consists simply of occluding the pylorus, forming a gastrojejunostomy, which keeps the duodenum decompressed in the early postoperative period. The duodenal exclusion does open at about three weeks, regardless of how you do it, even with staples. So it is a temporary exclusion of the duodenum.

We reviewed, subsequent to our initial report, 175 patients treated for duodenal injuries. The fistula rate was only 2% in the total group. Seventy-five of those patients had duodenal exclusion procedures for what we considered very severe injuries. In the other 100 patients, who had simple suture repair, we had no fistulas. Thus, we feel that one can separate those patients who need some extra protection of the duodenum from those who do not, and can use simple repair methods if it's a simple wound which can be well debrided and properly closed. Those wounds which devitalize a

portion of the duodenum constitute a wound which, on closure, may constrict, or have questionable success. These are better treated by pyloric exclusion, done by simple decompression, and we would recommend this procedure instead.

DR. H. HARLAN STONE (Atlanta, Georgia): Review of a 30-year experience with 321 patients who had sustained duodenal wounds confirmed that duodenal decompression is a very practical method to ensure an intact duodenal suture line. Of 57 patients who did not have duodenal decompression, 11 developed a duodenal complication, usually a leak, and four of these died of that single complication. Of 237 patients who had duodenal decompression, there was only one duodenal complication. This did lead to death, however, as the duodenal suture line disrupted and eroded into the aortic suture line, with sudden exsanguination.

We prefer to use a three tube decompression system, a gastrostomy with twin jejunostomies. The gastrostomy is a standard Stamm with Witsel jejunostomies distally. The distal jejunostomy can be used not only for feeding, but also for returning all collected secretions to the patient.

DR. RICHARD J. FIELD, JR. (Centreville, Mississippi): My mind runs along simple lines, and I'd like to drop back for a moment to some things that tell us why early diagnosis is so important. I'd like to discuss particularly blunt trauma of the abdomen, the retroperitoneal portion of the duodenum.

(slide) Dr. Hardy and I became interested in this down at the University of Mississippi several years ago, and we have found that one of the most sinister and difficult problems we face is when the duodenum alone is ruptured. It takes only a small force to do so,