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Artículo:

Duodenal injuries: Small but lethal lesions

ARTÍCULO DE REVISIÓN

Duodenal injuries: Small but lethal lesions

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Resumen

Objetivo: **Revisar conceptos actuales acerca de la definición, la identificación y el manejo de las lesiones duodenales.**

Obtención de la información: **Revisión selecta de la literatura (27 referencias)**

Selección de la información: **Se seleccionaron los artículos más importantes relacionados con lesiones duodenales.**

Resultados: **Las lesiones duodenales deben ser consideradas complejas cuando son de grados considerables en severidad o cuando están asociadas con lesiones extensas del páncreas, el colédoco distal o el ámpula de Vater. Las lesiones complejas se tratan mejor mediante el "control del daño" en los pacientes hemodinámicamente inestables. En los pacientes estables, estas lesiones se deben tratar con reparación duodenal, resección apropiada del páncreas y con el procedimiento de exclusión pilórica. Pocas veces se requiere de una pancreatoduodenectomía.**

Conclusión: **El trauma duodenal, con un diagnóstico temprano y tratamiento oportuno, puede ser manejado eficazmente con técnicas quirúrgicas simples. Las lesiones duodenales severas y aquéllas asociadas a una destrucción mayúscula de estructuras adyacentes (el complejo pancreatobiliar o los vasos abdominales) ameritan una estrategia meticulosa, que requiere de una consideración cuidadosa de la estabilidad fisiológica del paciente y la extensión de la destrucción local.**

Palabras clave: Duodeno, trauma, lesiones duodenales
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Abstract

Objective: **To review current concepts about definition, recognition and management of duodenal injuries.**

Data collection: **Selective review of the literature (27 references)**

Data selection: **The most relevant papers dealing with duodenal injuries were selected**

Results: **Duodenal injuries should be considered complex when the injury is of high grades in severity or when associated with extensive injury to the pancreas or distal common duct or the ampulla. Complex injuries are best treated by "damage control" in hemodynamically unstable patients. In stable patients, these injuries should be managed by repair of the duodenum, appropriate resection of the pancreas and the pyloric exclusion procedure. Rarely, pancreaticoduodenectomy is necessary.**

Conclusions: **Duodenal trauma, with an early diagnosis and prompt treatment, can be managed effectively by simple surgical techniques. Severe duodenal injuries and those associated with major destruction of adjacent structures (the pancreatobiliary complex or abdominal vessels) require a more thoughtful strategy that incorporates a careful consideration of the physiologic stability of the patient and the extent of local destruction.**

Key words: Duodenum, duodenal injuries, trauma
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Duodenal injuries are uncommon and are found only in 3.7% of all laparotomies for trauma.[1] Primary repair or duodenorrhaphy is successful in the majority of duodenal wounds. However, duodenal trauma can be complex and the management difficult, especially when the diagnosis is delayed as in blunt trauma or when massive injury to the pancreatico-duodenal-biliary complex occurs from penetrating trauma. This review will focus on the definition, recognition and management of duodenal injuries.

Incidence

Due to the increased incidence of automobile accidents, and the greater devastation of the modern weapons being used in violent assaults, duodenal injuries are seen with much greater frequency than 40 years ago. Although penetrating trauma is the most common cause of duodenal injuries, blunt trauma continues to predominate in rural areas. The reported incidence of duodenal injury ranged from 3.7% to 5% in the literature.[1,2] Sako and associates reported 17 duodenal injuries in 402 cases of abdominal trauma (4.2%) during the Korean war.[1,2] In 1968, Morton and Jordan reported an incidence of 5% among 280 patients with abdominal trauma.[3]

In a review of 17 series of 1,513 cases of duodenal injuries, Asensio and co-workers[1] reported an incidence of 77.7% occurring as the result of penetrating trauma and 22.5% from blunt trauma. In this report, among the 1,096 penetrating injuries, 74.6% were caused by gunshot wounds, 19.5% were due to stabbing, and 5.9% were the result of shotgun blasts. Among the 230 blunt injuries, 77.3% were caused by motor vehicle accidents, 9.6% by falls, 9.6% by assaults, and 3.5% by miscellaneous injuries.

While the mechanism of injury in penetrating trauma is a direct violation of the duodenal wall by the wounding agent, blunt injury causes duodenal disruption by complex mechanisms. The duodenum, which is retroperitoneal and highly mobile, is fixed at two sites by the common bile duct and the ligament of Treitz, lying against the bony vertebral column. Because of such a configuration and position, disruption of the duodenum by blunt forces can occur by crushing, as from a direct blow to the abdomen by a steering wheel. Shearing forces, as may occur during falls or a bursting energy , as with a seat-belt injury are other mechanisms involved.

The second portion of the duodenum is injured most commonly, in 35% of the cases.[1-4] The third and fourth portions are each injured in approximately 15% of the cases, and the first portion is wounded in only 10%. Multiple injuries are seen in the remaining 10%.

Diagnosis

Duodenal injuries from blunt trauma continue to pose a diagnostic challenge. The organ's retroperitoneal location may produce minimal and vague symptoms such as abdominal, back or flank pain. Pain radiating to the neck or testicles was also reported. The key to diagnosis is a high index of suspicion based on a consideration of the injury mechanism and an early diagnosis is essential. Lucas and Ledgerwood[5] reported a mortality of 11% in patients with blunt duodenal trauma treated within 24 hours as compared to a rate of 40% if the treatment was delayed for more than 24 hours .

Although routine laboratory tests are not helpful in the pre-operative diagnosis of duodenal rupture, some authors found the serum amylase to be important. Levinson and colleagues[6] and Snyder and co-workers[7] noted that the serum amylase was elevated in 50% of patients with duodenal or upper gastrointestinal injury. Others, however, failed to confirm these findings and cautioned against hyperamylasemia as an indication for exploratory laparotomy.[4,8,9] If serum amylase is elevated, a diligent search for duodenal rupture is warranted. The presence of a normal serum amylase level, however, does not exclude a duodenal injury.

Radiologic studies may be helpful in the diagnosis. Plain films of the abdomen may show retroperitoneal air **(Figure 1)**, free intraperitoneal air or air in the biliary tree. Other signs such as obliteration of the psoas muscle shadow and scoliosis of the lumbar vertebrae should trigger a suspicion for duodenal trauma. Most authors noted radiographic signs of duodenal rupture in less than one third of patients.[2,10,11] One notable exception is the report from Lucas and Ledgerwood.[5] This paper documented retroperitoneal air on X-Ray in more than 50% of the patients with duodenal injuries. These authors also observed that more than 90% of the patients had some signs of duodenal rupture on plain radiographs.

Currently, CT scan of the abdomen with intraluminal and intravenous contrast is the diagnostic test of choice in stable patients with blunt abdominal trauma in whom retroperitoneal injury is suspected. It has a high degree of accuracy in detecting retroperitoneal injuries. It also is very sensitive to the presence of small amounts of retroperitoneal air, blood, or extravasated

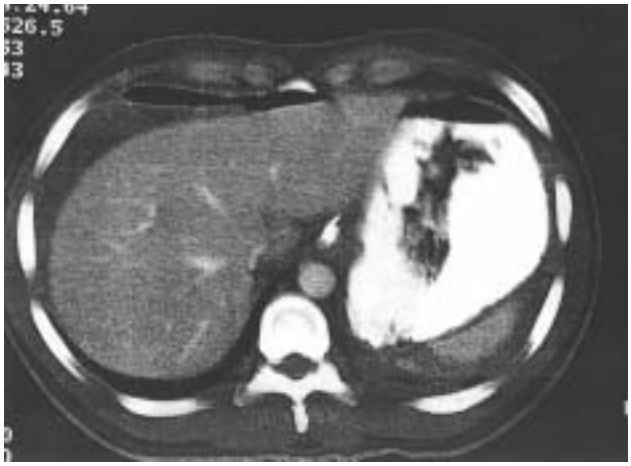

Fig. 1. CT abdomen showing free air and pneumoperitoneum.

contrast from the injured duodenum.[12-14] Exploratory laparotomy remains the ultimate diagnostic test, if a high degree of suspicion of duodenal injury continues in the face of absent or equivocal radiographic signs.

Intra-operative assessment: Asset routine is important for exploration of the retroperitoneum, since subtle injuries may easily be missed. After control of hemorrhage, special attention is directed to detect bile staining of the retroperitoneum, small bubbles of entrapped air in the periduodenal tissues and small periduodenal hematomas. These may be the earliest clues suggestive of a lacerated duodenum. The next step is to Kocherize the entire duodenum. This will facilitate inspection of the first, second and a portion of the third parts of the organ. The Cattell and Braasch maneuver consists of mobilization of the hepatic flexure of the colon, sharp dissection of the small bowel attachment from the ligament of Treitz to the right lower quadrant and cephalad displacement of the small bowel. This will bring the third portion of the duodenum into view and also will facilitate an assessment of the integrity of the pancreas. The fourth portion of the duodenum may be palpated by mobilizing the ligament of Treitz.

Optimal management of duodenal injuries require a complete assessment of the associated injury to the pancreas as well as the bile duct and the ampulla. Therefore, an injury to the duodenal sweep in the second portion must prompt an evaluation of these structures **(Figure 2A** and **2B)**. If there is a laceration of the second portion of the duodenum, injury to the adjacent portion of the pancreas and the integrity of the major pancreatic duct is in question, an intra-operative pancreatography may be helpful and influence the decision to perform simple or complex procedures.

Intra-operative pancreatography: The ampulla is located either by inspection or palpation. Through the duodenal laceration, the ampulla may be located by careful inspection of the medial wall of the second portion. Palpation of the area to feel for the pouting mucosa may facilitate the identification. Occasionally, intravenous injection of secretin to stimulate pancreatic secretion may be required but has not been necessary in our experience. Once the papilla is located, the common channel of the distal common bile duct and pancreatic ducts is cannulated with a small feeding tube, about 3 ml of dilute hypaque solution are injected and a portable radiograph is obtained. The pancreatic duct is usually visualized in its entirety and an assessment of ductal integrity may be confirmed. We have been successful in demonstrating the duct in a majority of the instances. While occasional reports have mentioned an intra-operative endoscopic retrograde cholangiopancreatography, we believe that direct cannulation of the duct is easier and faster.

Definition of complex injuries

Severe duodenal injury, according to Snyder et al,[7] is associated with the following factors: 1) missile or blunt injury; 2) injury of the first or second portions of the duodenum; 3) an injury-operation interval of > 24 hours; and 4) adjacent common duct injury. **Table I** describes the organ injury scale for the duodenum and **Table II** summarizes the scale for pancreas as recommended by the organ injury scaling committee of the American Association for the Surgery of Trauma.[15,16] Grades III to Grade V are complex duodenal injuries. Combined pancreatoduodenal injuries and injuries involving the distal common duct and the periampullary area (Grades III to V of pancreatic injuries and Grade V of biliary tract injuries) must also be considered as complex injuries and need careful consideration of operative treatment. Blunt traumatic lacerations of minor grades, when the diagnosis and operative treatment are delayed and the tissues are edematous and inflamed , must also be considered as complex injuries. Similarly, extensive penetrating

2A **2B**

Fig. 2. (A and B) Duodenal disruption from a steering wheel injury in a MVC.

injuries involving major abdominal vessels, even though associated with minor grades of duodenal injuries must be considered complex.

Treatment

In the hemodynamically unstable patient, the optimal treatment is an abbreviated laparotomy with control of hemorrhage, rapid closure of gastrointestinal lacerations by suture or stapling , provisional closure of the skin and Intensive Care Unit resuscitation : the so-called "damage control" approach.[17] Restoration of the continuity of the GI tract is accomplished at a secondary operation, when the patient's hypothermia, acidosis and coagulopathy have been corrected and resuscitation parameters have been optimized.

Table I

Duodenal Injury Severity (AAST Organ Injury Scaling Committee): D1, D2, D3, D4: first, second, third and fourth portions of duodenum. For multiple injuries the grade is advanced one

Grade	Injury	Description
I	Hematoma	single portion of duodenum
	Laceration	partial thickness only
II	Hematoma	involving > one portion
	Laceration	disruption < 50% circumference
III	Laceration	disruption 50%-75% circumference of D2
		disruption 50%-100% circumference of D1, D3, D4
IV	Laceration	disruption > 75% circumference of D2
		Involving ampulla or distal common duct
V	Laceration	massive disruption of duodenopancreatic complex
		devascularization of duodenum

Table II

Pancreatic injury severity (AAST Organ Injury Scaling Committee). For multiple injuries, the Grade is advanced one. (Modified from Journal of Trauma 1990;30:1340.)

Grade	Injury description
I	Minor contusions or superficial lacerations, no ductal injury
II	Major contusions or lacerations, no ductal injury, no tissue loss
III	Distal transection of the pancreas or a parenchymal injury involving the duct
IV	Proximal transection (to the right of SMV) or a parenchymal injury involving the ampulla
V	Massive disruption of the pancreatic head

The vast majority of duodenal injuries may be managed by simple procedures such as debridement and primary repair or resection and anastomosis. This is especially true of penetrating injuries, where early operative treatment is the rule rather than the exception.[18-20] In the small number of complex duodenal injuries, there is a real potential for duodenal fistulization and increased morbidity. This has prompted surgeons to add a variety of adjunctive operative procedures to protect the duodenal suture line in an attempt to prevent the complication.[21-24]

Martin and co-workers[21] and Kashuk and associates[22] noted that 41% and 48% of their patients had required complex procedures for duodenal repair. The following discussion will summarize the available options and lead to a suggested algorithm for the management of severe injuries of the duodenal, pancreatic and biliary complex.

Tube decompression: Originally introduced by Stone, "triple ostomy", consisting of a gastrostomy, duodenostomy and jejunostomy, was recommended by Stone and Fabian.[10,11] These authors observed only one duodenal fistula in 237 patients when tube decompression was used, while 8 of 44 patients without the decompression developed this complication. Other authors also recommended tube duodenostomy for decompression of the duodenum and protection of the duodenal suture line.[4,13,15] The tube decompression can be achieved either antegrade, proximal to the injury site or retrograde, via a jejunostomy. The benefits of duodenostomy tubes were not, however, seen by all. Snyder and co-workers[7] did not find a statistically significant difference in duodenal fistula rate between patients treated with duodenorrhaphy and tube decompression and patients treated with duodenorrhaphy alone. In a multi center study of 164 patients with duodenal injuries, Cogbill and associates[23] concluded that tube duodenostomies were neither necessary nor effective in preventing duodenal fistula. Ivatury and colleagues[18,19] found an increased incidence of duodenal fistula and complications when duodenal decompression was used. Our current preference is to avoid duodenostomy tubes. In patients with complex duodenal injuries, we would rather rely on the pyloric exclusion procedure (as discussed below) to protect the duodenal suture line. A feeding jejunostomy distally in the jejunum is, however, employed in patients with extensive abdominal injury (Abdominal Trauma Index > 25).

Resection and end to end anastomosis: If the duodenal injury has caused a large defect in the wall (longer than 3 cm in diameter), primary closure of the defect may narrow the lumen of the bowel or result in undue tension and subsequent suture line breakdown. Segmental resection and primary end to end duodeno-duodenostomy is usually feasible when dealing with injuries to the first, third and fourth portion of the duodenum. This may be technically difficult when dealing with an injury to the second portion since the ampulla of Vater and the intimate relationship of the duodenum to the pancreas may limit adequate mobilization. In such

patients a serosal patch of jejunum may be sutured to the edges of the duodenal defect. Although the addition of such a jejunal serosal patch to duodenal repair is attractive, its superiority over simple repair alone has not been documented.[18,19]

Our preferred option when dealing with large duodenal defects that cannot be repaired by resection and primary end-to-end duodeno-duodenostomy, especially in the second portion of the duodenum, is to perform either side-to-end or end-to-end Roux-en Y duodenojejunostomy[2] or a side-to-side duodenojejunostomy.

Duodenal exclusion procedures: More complex procedures such as duodenal diverticulization or pyloric exclusion should be considered for severe duodenal injuries. The main purpose of such procedures is to exclude the duodenal repair from gastric secretions and allow time for adequate healing of the duodenal repair.

Duodenal diverticulization was first described by Berne and associates in 1968[24] for the treatment of combined extensive injury to the duodenum and pancreas or severe injury of the duodenum alone. The operation consists of suture closure of the duodenal injury, gastric antrectomy with end to side gastrojejunostomy, tube duodenostomy and generous drainage in the region of the duodenal repair. Truncal vagotomy and biliary drainage can be added. Berne and associates reported on 50 patients with this procedure in two series; seven or 14% developed duodenal fistulas. The overall mortality rate was 16%. The main problem with duodenal diverticulization is that it is a time consuming operation, ill advised in a hemodynamically unstable patient or when multiple injuries are present. Furthermore, it requires an antrectomy of an uninjured stomach.

A superior variant of excluding the duodenal suture line and diverting gastric contents is pyloric exclusion. It was originally described by Summers in 1903[1] and was first used clinically by Jordan in the early 1970s.[1,25] After primary repair of the duodenal wound is achieved, a gastrotomy incision is made on the greater curvature of the antrum over its most dependent portion, at a site suitable for a gastrojejunostomy. The pyloric ring is identified and grasped from inside the gastrotomy. It is then closed with a running suture of a non absorbable suture such as polypropylene. Alternatively, a staple line may be placed across the pylorus. A gastrojejunostomy is performed at the gastrotomy site. Irrespective of the method used to close the pylorus, care must be taken to avoid closure of the prepyloric antrum as this will cause increased gastrin secretion and elevated gastric acid output. In 1983, a 12-year experience with pyloric exclusion was reported by Martin and associates.[21] One hundred twenty eight of 313 patients (41%) with duodenal injuries underwent this procedure with a duodenal fistula rate of 5.5%.

Vagotomy was not included in the original pyloric exclusion procedure and a major concern has been its ulcerogenic potential. In the report by Martin and colleagues,[21] marginal ulceration was noted in four of the 42 patients who underwent post operative GI tract evaluations. Two of these patients required surgical intervention and the other two patients responded to medical therapy. It is also noteworthy that, among the 42 patients studied with gastro intestinal examination, 94% had patency of pylorus when examined three weeks or more after the operation. Our current approach is a liberal use of pyloric exclusion procedure without vagotomy in all patients with complex duodenal injuries.

Pancreaticoduodenectomy: Rarely performed for abdominal trauma, this extensive procedure is a difficult choice. It should be reserved for patients with massive peripancreatic hemorrhage, proximal pancreatic duct or ampullary injuries that preclude reconstruction, and combined devascularizing injuries to the duodenum and head of the pancreas.[23-27] Among 247 patients with duodenal injuries, pancreaticoduodenectomy was performed for 7 patients, an incidence of only 3%.[7] In a series of 129 patients with combined pancreaticoduodenal injuries, Feliciano and colleagues[25] reported that only 13 patients had resection of the duodenum and the pancreatic head. In 1984, Oreskovich and Carrico[26] reported no deaths in 10 patients undergoing pancreaticoduodenectomy, a remarkable achievement. In a collective review of the literature, Asensio and colleagues[1] identified 170 patients who underwent pancreaticoduodenectomy in 50 reported series. The overall mortality rate was 33%. This high mortality of the Whipple procedure for trauma is primarily related to associated vascular injuries. "Damage Control" and staged reconstruction for severe pancreaticoduodenal injuries is a novel concept that should benefit these patients. At the original operation, control of the hemorrhage is obtained, along with ligation of the common bile duct and pancreatic duct, stapling of the gastrointestinal injuries and stapling of the bleeding pancreas. The patient is brought back to the operating room in 24-28 hours, after adequate hemodynamic stabilization, correction of coagulopathy, acidosis and hypothermia. Definitive reconstruction is performed at this stage and is actually facilitated by the dilatation of the common bile and pancreatic ducts that were ligated at the initial operation.[12] Another important advance in pancreaticoduodenectomy for trauma was suggested by Gentilello and associates.[27] They preferred to ligate the pancreatic duct instead of pancreaticojejunostomy after resection because of the technical difficulties of the anastomosis in a physiologically unstable patient. In their series of 13 patients, survival was 46%. None of the survivors had diabetes on long-term follow-up. The incidence of pancreatic fistula and malabsorption was 50 % in the survivors which was comparable to those who had pancreaticojejunostomy. Based on this experience, the authors concluded that duct ligation is an option after pancreaticoduodenectomy. This should be borne in mind by surgeons dealing with these difficult injuries.

Special situations

Injuries to the intramural portion of the common bile duct are extremely rare. Extensive local tissue damage (intraduodenal or intra pancreatic bile duct inju-

ries or Grade V injuries as defined by the AAST Organ Injury Scaling Committee) would probably necessitate a staged pancreaticoduodenectomy. More local injuries however, can occasionally be managed by intraluminal stenting, sphincteroplasty and stenting, or reimplantation of the ampulla.

Combined pancreatoduodenal injuries deserve a special mention. Minor grades of duodenal and pancreatic injuries may be treated by simple techniques of debridement and repair of duodenal laceration and debridement and drainage of the pancreatic injury. Other combinations of injuries involving severe grades of either duodenal or pancreatic trauma may occur. These injuries require more complex procedures such as pyloric exclusion and pancreaticoduodenectomy. For instance, in the series of 129 patients with combined pancreaticoduodenal injuries described by Feliciano et al,[25] simple repairs with drainage were performed in only 24% of the patients. More than 50% had pyloric exclusion. The authors had remarkable results with only two duodenal and two pancreatic fistulas. The recommendations of the authors for the optimal management of these combined injuries are summarized: 1. Primary repair and drainage for simple duodenal injuries (Grades I, II) with nonductal pancreatic injury (Grades I, II). 2. More extensive duodenal injuries combined with pancreatic injuries not involving the duct to the right of superior mesenteric vessels are best treated with repair or resection of both organs as indicated, pyloric exclusion, gastrojejunostomy and drainage. 3. Lacerations in the head of the pancreas with ductal involvement, devascularizing lesions of the duodenal or duodenal lacerations with destruction of the ampulla and distal common duct (Grade V injuries of these structures in any combination) are best treated by a one-stage or two-stage pancreaticoduodenectomy as discussed above.

Morbidity and mortality

The most serious complication following the treatment of duodenal injury is the development of a duodenal fistula from suture line dehiscence. In a collective review of 15 series with 1408 patients of duodenal injuries , Asensio and colleagues[1] noted a 0% to 17% incidence of duodenal fistula with an average rate of 6.6%. Other complications reported with duodenal trauma (may or may not be directly related to the duodenal injury itself) include: 1) intra-abdominal abscess, 10.9 to 18.4%; 2) pancreatitis, 2.5% to 14.9%; 3) duodenal obstruction, 1.1% to 1.8%; and 4) bile duct fistula, 1.3%.[1]

The management of a duodenal fistula consists of extensive drainage, nutritional support by intravenous hyperalimentation or, preferably, by enteral feeding through a jejunostomy, drainage of all associated intrabdominal abscesses and antibiotic therapy. If the patient has undergone duodenal exclusion (duodenal diverticulization or pyloric exclusion) at the original operation, such fistula is an end fistula and, usually, will close with conservative management. If, however, a duodenal exclusion has not been performed, and a high output fistula persists beyond 3 weeks despite adequate drainage and nutritional support, duodenal exclusion at a reexploration should be considered.

The overall mortality rate of duodenal injuries continues to be significant. Several series reported a range of 5.3% to 30% with an average of 17%. This mortality, however, is related more to the extent of associated vascular injuries and injury to the adjacent head of the pancreas. When early death from exsanguination is excluded, the mortality rate attributed to the duodenal injury itself ranges from 6.5% to 12.5% and is related to duodenal fistulization, intra-abdominal abscess, sepsis and multiorgan failure. The mortality rate attributed exclusively to fistula formation ranges from 0 to 3.9%.[1] In the multi-center report by Cogbill and associates,[23] the mortality rate for blunt trauma was 14.4%. The rate was only 3.6% for penetrating trauma, a difference mostly attributed to a delayed diagnosis of blunt duodenal injury.

Conclusions

Duodenal trauma, with an early diagnosis and prompt treatment, can be managed effectively by simple surgical techniques. Severe duodenal injuries and those associated with major destruction of adjacent structures (the pancreatobiliary complex or abdominal vessels) require a more thoughtful strategy that incorporates a careful consideration of the physiologic stability of the patient and the extent of local destruction.

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