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Editorial: RIFAT LATIFI: The First Chapter of the New Book of Kosova College of Surgeons

RUSSELL ANDREWS: The Importance of Surgical Care to Achieve the United Nations Sustainable Development Goal for Healthy Lives by 2030

BELLAL JOSEPH: Breaking the Frailty Code: Emergency General Surgery in the Elderly

DEMETRIUS LITWIN: Hand-Assisted Laparoscopic Living Donor Hepatectomy

LIOR LEVY, ABASS SMILEY, RIFAT LATIFI: Independent Predictors of In-Hospital Mortality in Patients Undergoing Emergency Admission for Arterial Embolism and Thrombosis in the USA: A 10-Year National Dataset

LIOR LEVY, ABBAS SMILEY, RIFAT LATIFI: Mortality in Emergently Admitted Patients with Empyema: An Analysis of 18,033 Patients

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Pancreato-Duodenal Injuries: Current Concepts



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Abstract

Pancreato-duodenal injuries are uncommon. They can be lethal, ranging from delayed diagnosis in the case of blunt trauma to associated major vascular injuries in penetrating trauma. A simplistic approach with primary repair or resection and anastomosis is ideal for most duodenal injuries. Simple hemostatic measures and closed suction drainage are appropriate for pancreatic injuries. Complex procedures such as pyloric exclusion may be indicated for delayed treatment or severe, high-grade combined pancreato-duodenal injuries. A high index of suspicion and a judicious treatment plan based on a careful consideration of all the available options are crucial to obtain the optimal outcome.

Keywords: Pancreato-duodenal injuries, current concepts, simplistic and complex procedures.

Introduction

Duodenal injuries are uncommon and are found in only 3.7% of all laparotomies for trauma.[1, 2] The duodenum, as well as the pancreas, are retroperitoneal in proximity to vital biliary and vascular structures. The management of blunt trauma may be delayed because of the subtlety of signs and symptoms. Penetrating trauma is challenging because of associated injury to major vessels in the upper abdomen.[1–8] This review will focus on recent trends in the management of pancreato-duodenal trauma.

Penetrating trauma is the most common cause of urban duodenal injuries, with blunt trauma predominating in rural areas. The reported incidence ranged from 3.7% to 5% in the reviewed literature,[1, 2] with 77.7% occurring as the result of penetrating trauma and 22.3% from blunt trauma.[1-10] Blunt injury causes duodenal disruption due to a crushing force against the vertebral column or by shearing forces, such as falls. The second portion of the duodenum (DII) is injured commonly, followed by the third (DIII), fourth (DIV), and first (DI) parts, in that order. Pancreatic trauma also is rare. It is potentially lethal because it is often associated with major vascular injuries. Not uncommonly, it has a late clinical presentation, which in turn complicates the management and overall prognosis. The most common blunt trauma is caused by road traffic accidents and "handle-bar " injuries.[9,10]

Upon patient presentation, the choice between

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immediate surgical exploration or further imaging studies is dependent on the hemodynamic status of the patient. If the patient is hemodynamically stable or is a transient responder, Computed Tomography should be performed, with the customary FAST examination preceding it. The signs to look for are: free fluid in the peritoneal cavity or the retroperitoneal area, thickening of the bowel wall, etc. The hallmarks of pancreatic injury on Computed Tomography (CT) are: peri-pancreatic hematoma, retroperitoneal edema, disruption of the body of the pancreas, and loss of definition of the pancreas by inflammatory changes. These findings may not be evident in the initial CT done soon after trauma occurs. A delayed CT in 12-24 hours may delineate the injury more clearly.[9,10] Serum amylase and lipase levels have high false-positive and false-negative rates. The ultimate diagnostic test, if a high degree of suspicion continues in the face of absent or equivocal radiographic signs, is surgical exploration.[1-10]

In very stable patients with minimal symptoms, MRCP or magnetic resonance cholangiopancreatography can be useful. In our institution, 10 hemodynamically stable patients with clinically suspected pancreatic injury from abdominal trauma, 8 blunt trauma patients, and 1 patient each for penetrating and iatrogenic trauma, underwent MRCP.[11] The MRCP findings were correlated with endoscopic retrograde cholangiopancreatography; ERCP(n = 2); surgical findings (n = 1); computed tomographic scans (n = 10); and with clinical, biochemical, or imaging follow-up (n=10). Diagnostic quality MRCPs were obtained in all patients, and the mean imaging time was only five minutes. Acute or subacute pancreatic duct injuries were detected in four patients; pseudocysts were detected in three of these four patients. MRCP revealed a posttraumatic stricture in one patient who had sustained blunt abdominal trauma 17 years previously. Pancreatic duct trauma was excluded in the other patients. MRCP enabled noninvasive detection and exclusion of pancreatic duct trauma and pancreas-specific complications.

Grading of Injury Severity: The organ injury scaling (OIS) for the duodenum and the pancreas, as defined by the American Association for the Surgery of Trauma (AAST), ranges from simple (Grade I) to the most severe (Grade V).[12] Grades III to V are complex duodenal injuries, as are combined pancreatoduodenal injuries and injuries involving the distal common duct and the periampullary area. Even minor lacerations of the duodenum, when diagnosed in a delayed fashion, must also be considered complex injuries due to the presence of tissue edema and reaction. The AAST grading of pancreatic injury is as follows: grade I minor contusion without duct injury, or superficial laceration without duct injury; grade II major contusion or laceration without duct injury or tissue lost; grade III distal transaction or parenchymal injury with duct injury; grade IV proximal (to right of the superior mesenteric vein) transection or parenchymal injury with duct injury; and grade V massive disruption of pancreatic head.[12]

Management: Endoscopic retrograde pancreatography (ERCP) has a role in minimally symptomatic patients, both for diagnosis and therapy. Wolf et al.[13] performed ERCP on a total of five patients with suspected injuries to the pancreas after blunt abdominal trauma; no duct injury could be determined in three of the patients. A 44-year-old woman sustained severe internal and external injuries after a traffic accident. Due to the nature of her injuries, pancreatic resection with splenectomy was necessary. Following the operation, a pancreatic fistula was diagnosed. The pancreatic duct was stented with the use of ERCP. In another case, a 24-year old woman was kicked in the epigastrium by a horse. On the day after the incident, she complained of increasing pain in the upper abdomen, and she had elevated amylase and lipase levels. A CT scan showed free fluid. Subsequently, an ERCP was performed within 48 hours of the injury, and a leakage from the duct in the head-body region was identified. Next, a stent was placed during laparoscopic drainage. After 14 days, the patient was sent home, the drain was removed, and the stent was taken out after 12 weeks.

***Isolated pancreatic injury* (14-18):** Recently, organ preservation of the pancreas in pediatric patients, akin to nonoperative treatment of splenic trauma, is being investigated. Canty et al.[14] described two children who had blunt abdominal trauma and underwent ERCP within hours of injury. In case 1, a stent was threaded through the disruption into the distal duct. In case 2, a similar injury, the stent was placed through the ampulla, thereby, reducing ductal pressure. In both cases, clinical improvement was rapid with the complete resolution of clinical and chemical pancreatitis, resumption of a normal diet, and discharge from the hospital. The stents could be

removed at 10 and 12 days post-injury with good response immediately, and with follow-up ERCP and CT scans 1 year post injury. Garvey et al.[15] reported on nine patients (mean age 7.8 years) who underwent ERCP. Seven (78%) had pancreatic injuries, while two (22%) had bilateral hepatic duct injuries. The median time to diagnosis was one day (range, 0-12). Two had distal pancreatectomy, five had stents placed (two biliary and three pancreatic), and four sphincterotomies were performed. Despite pancreatic stenting, one patient required distal pancreatectomy for persistent leak. The median hospital length of stay was 11 days. The authors concluded that ERCP can safely provide definitive treatment for some patients. Houben and associates[16] described 15 children with pancreatic trauma. Of those, 12 had ERCP and CT/MRCP at a median 11 days after injury. Ductal injuries (grades II and III) were seen in 6 patients. Nine patients with Grade IV injuries were treated by transductal pancreatic stent. Four children needed CT/US guided drainage for acute fluid collections. Additionally, 2 children had endoscopic cyst-gastrostomy. One of them later required conversion to an open cyst-gastrostomy. Jobst et al.[17] concluded from their series of 56 children that the majority of pancreatic injuries can be managed nonoperatively. Wood et al.[18] analyzed 43 children with pancreatic injury and concluded that operative management of children with grades II to IV pancreatic injury resulted in significantly decreased rates of pancreatic complications; ERCP was a useful diagnostic modality for guiding operative vs. nonoperative management decisions.

Surgical treatment: Pancreato-duodenal injury should be pursued during the initial exploratory laparotomy after the surgeon has controlled all sources of ongoing surgical bleeding and bowel contamination.[1-10] Even at celiotomy, small wounds of the duodenum may be easily overlooked. The subtle signs are: bile staining of the retroperitoneum, small bubbles of entrapped air in the peri duodenal tissues, and small peri duodenal hematomas. Kocherization (mobilization of the C-loop of the duodenum from its retroperitoneal attachment) is the next step. This facilitates inspection of DI, DII, and a portion of DIII. This maneuver will also allow an evaluation of the pancreatic head, periampullary area, and distal CBD. 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 DIII into view along with the body of the pancreas. DIV may be evaluated by mobilizing the ligament of Treitz. The entire body of the pancreas will be amenable to close inspection and careful palpation, as well as looking for small hematomas and depressions suggesting a fracture etc.[1-10]

The surgical management of pancreato-duodenal injuries depends on hemodynamic stability, severity of duodenal injury, and the associated pancreatic injury.[1–10, 19-20] In the hemodynamically unstable patient, the optimal treatment is an abbreviated laparotomy and damage-control resuscitation.[19-22] If the patient develops hemodynamic instability during or prior to the procedure, with a sustained SBP (70 mmHg or less), the placement of a Resuscitative Balloon Occlusion of the Aorta (REBOA) should be considered and placed in zone I as an adjunct.[20] The priorities consist of control of the hemorrhage and restoration of the deranged physiology. Gastrointestinal perforations and lacerations are sealed by rapid, provisional methods such as suture; stapling; rapid resection without establishing continuity; temporary abdominal closure; and intensive care unit resuscitation: the so-called damage control approach. Restoration of the gastrointestinal tract integrity is accomplished at a second operation. Due to delayed closure, duodenal repair may not be as easy as when done primarily. The techniques for delayed treatment are described below.

In hemodynamically stable patients, most duodenal injuries, lower grade lesions of the duodenum and pancreas, and low velocity penetrating wounds as in civilian injuries when there was no delay in diagnosis and treatment, simple repair is the optimal approach.[1-8, 19,22] Adequate debridement of the duodenal wall around the laceration back to bleeding tissue; careful repair employing standard surgical techniques, e.g., one to two layers; transverse closure of longitudinal wounds; and converting adjacent wounds into one wound closure, etc., will provide excellent results. Our preferred option when dealing with large duodenal defects is resection and end-to-end duodeno-duodenostomy. In DII such resections are not feasible; a useful option is side-to-end or end-to-end Roux-en-Y duodeno-jejunostomy, or a side-to-side duodeno-jejunostomy.

The following are recommended for pancreatic injuries:

AAST Grade I pancreatic injury: hemostasis and +/- surgical drainage;

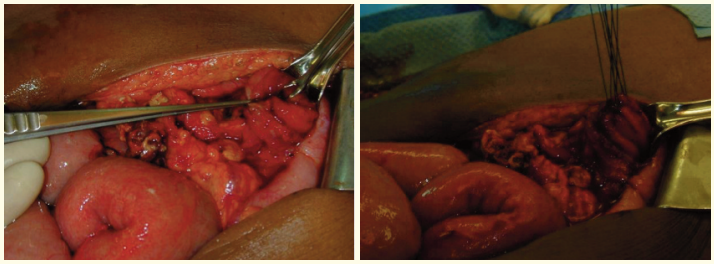
AAST Grade II: simple hemostatic methods, and, if bleeding does not stop, pancreatic laceration repair with non-absorbable monofilament 3-0 suture (interrupted or continuous depending on surgeon's preference) and surgical drainage;

AAST Grade III: hemostasis, distal pancreatectomy +/- splenectomy for injuries of the distal tail of the pancreas with significant tissue destruction.

For all other injuries: continuous locking non-absorbable monofilament 3-0 suture of the transected borders of the lacerated pancreas, ligation of the two ends of the transected pancreatic duct, and surgical drainage.[1-8, 19, 22, 23]

***Complex injuries, delayed treatment*:** Only a small number of duodenal injuries are complex, as defined above. These have 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 this complication: ''triple ostomy'' (gastrostomy, duodenostomy, and jejunostomy), some variant of tube duodenostomy, or a serosal patch of the duodenal repair with a loop of jejunum. Current opinion[1-8] argues against ''routine'' tube duodenostomy and suggests that indiscriminate tube duodenostomy may increase the complication rate.

Duodenal repair and exclusion[23, 25-30] appears to be the favored approach in difficult situations for delayed



Figures 1&2: Pyloric exclusion by suture-closure of pyloric ring

treatment. The objective of duodenal exclusion is to divert gastric secretions away from the duodenal repair and allow time for the adequate healing of repair. This is now accomplished by the pyloric exclusion procedure and gastrojejunostomy. Duodenal repair would be followed by closure with non-absorbable sutures of the pylorus (usually Prolene), accomplished through a gastrotomy incision on the greater curvature of the antrum. Alternatively, a staple line may be placed across the pylorus. A gastrojejunostomy is then performed at the gastrotomy site. The first large series of this procedure was reported by Vaughan et al.[26] from Ben Taub Hospital. In 1983, a 12-year experience with pyloric exclusion was reported from the same institution. In total, 128 of the 313 (41%) patients with duodenal injuries underwent this procedure, with a duodenal fistula rate of 5.5%. Interestingly, 94% had restoration of the patency of the pylorus when examined 3 weeks or more after the operation. It must be mentioned, however, that there have been no controlled studies to establish the superiority of pyloric exclusion. Recent reports have argued on both sides of the question: in favor, or against pyloric exclusion.[27-30] Pyloric exclusion is certainly a possible option for patients with a delayed diagnosis or treatment of higher grade pancreato-duodenal trauma.

Pancreato-duodenectomy is the ultimate option for extensive injuries causing uncontrollable peripancreatic hemorrhage, distal bile duct, proximal pancreatic duct or ampullary injuries with extensive tissue destruction, and combined devascularizing injuries to the duodenum and head of the pancreas. Among 247 patients with duodenal injuries, pancreaticoduodenectomy was performed on seven patients, an incidence of only 3%.[23-25] The overall reported mortality rate for this operation was 33%. This high mortality is related primarily to associated vascular injuries. Abbreviated laparotomy on unstable patients with staged reconstruction should make this rare operation for trauma a better option than that of the past. Definitive reconstruction is performed at the second operation when the patient's physiology is less deranged.

***Combined pancreaticoduodenal injuries*:** based on an analysis of 129 patients with combined pancreaticoduodenal injuries, Feliciano et al.[23] put forth these recommendations for optimal results. (1) Primary repair and drainage are used for simple duodenal injuries with nonductal pancreatic injury (Grades I and 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 duodenum, pyloric exclusion, gastrojejunostomy, and drainage. (3)

Lacerations in the head of the pancreas with ductal involvement, devascularizing lesions of the duodenum, 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.

Table 1 describes a scheme for the management of pancreatoduodenal injuries.

Morbidity and Mortality

The most serious complication following the treatment of duodenal injury is the development of a duodenal fistula from the suture line dehiscence. In a collective review of 15 series with 1,408 patients with duodenal injuries, Asensio et al.[1,2] 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%. As outlined above, 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 intraabdominal abscesses; and antibiotic therapy.

A. Duodenal injury of low grades, Early diagnosis
Primary closure after debridement
or resection and EEA
Duodeno-duodenostomy/jejunostomy for large defects
B. Combined pancreatoduodenal injuries, Delayed treatment
Grades I & II :
repair of duodenum, drainage of pancreas
Grade III :
Duodenal repair/ resection and EEA, distal
Pancreatectomy
± pyloric exclusion
Grades IV,V
Pancreato-duodenectomy (one or two stage)
C. Hemodynamic instability
Damage-control surgery

Table 1 : Scheme of treatment for pancreato-duodenal injuries

The overall mortality rate of duodenal injuries continues to be significant, up to 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, intraabdominal abscess, sepsis, and multiorgan failure. The mortality rate attributed exclusively to fistula formation ranges from 0 to 3.9%.[1,2] The reported overall incidence of pancreatic fistula has been between 8 to 33% in patients that have undergone distal pancreatectomies for trauma.[11,20-22]

Gaining access to the small bowel for enteral nutrition is a crucial component of the successful management of complex injuries. A naso-enteric tube or a feeding jejunostomy must be pre-planned when dealing with gaining access, either at the primary operation or subsequent re-operations by anticipating a difficult post-operative course. Similarly, efficient closed-suction drainage will facilitate a "retroperitoneal laparostomy" in patients with an improved outcome.[31]

In conclusion, pancreato-duodenal injuries are uncommon but lethal, ranging from a delayed diagnosis in the case of blunt trauma to associated major vascular injuries in penetrating trauma.

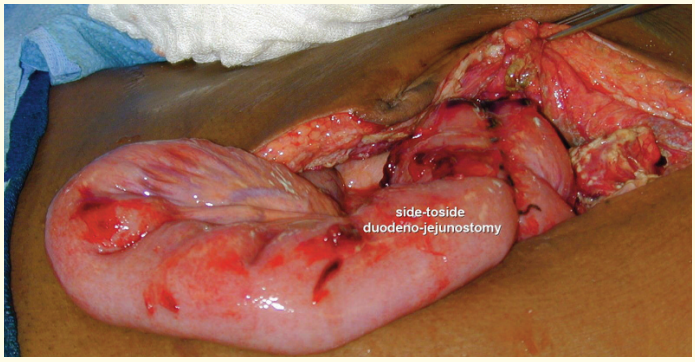


Figure 3: Side-to-side duodenojejunostomy

Damage-control principles for hemodynamically unstable patients and a simplistic approach with primary repair or resection and anastomosis is the optimal approach. Simple hemostatic measures and closed suction drainage are also appropriate for pancreatic injuries. Complex procedures such as pyloric exclusion may be indicated for delayed

treatment or severe, high-grade combined pancreato-duodenal injuries. A high index of suspicion for early diagnosis and a conservative surgical treatment plan will result in good outcomes.

Conflict of Interest Disclosure Statement

The author has no conflict of interest to declare.

REFERENCES

1. Asensio JA, Petrone P, Roldán G, et al. Pancreatic and duodenal injuries. complex and lethal *Scand J Surg*. 2002;91(1):81-6. doi: 10.1177/145749690209100113.:

2. Ivatury RR, Malhotra AK, Aboutanos MB, Duane TM . Duodenal Injuries; A review. *Eur J Trauma Emerg Surg*. 2007;33:231–7. DOI 10.1007/s00068-007-7078-5

3. Ivatury RR, Nallathambi M, Gaudino J, et al. Penetrating duodenal injuries: analysis of 100 consecutive cases. *Ann Surg*. 1985;202:153–8.

4. Ivatury RR, Nallathambi MN, Rao PM, et al. Penetrating pancreatic injuries. *Am Surg*. 1990;2:90–5.

5. Nassoura ZE, Ivatury RR, Simon RJ, et al. A prospective re-appraisal of primary repair of penetrating duodenal injuries. *Am Surg*. 1994;60:35–9.

7. Cogbill TH, Moore EE, Feliciano DV, et al. Conservative management of duodenal trauma: a multi-center perspective. *J Trauma*. 1990;30:1469–75.

8. Ferrada P, Wolfe L, Duchesne J. Management of duodenal trauma: A retrospective review from the Panamerican Trauma Society. *J Trauma Acute Care Surg*. 2019; 86(3):392-396.

9. Jurkovich GJ. Pancreatic Trauma. *J Trauma Acute Care Surg*. 2020; 88: 19-24. doi: 10.1097 TA.0000000000002546.

10. Potoka DA, Gaines BA, Leppäniemi A, Peitzman AB. Management of blunt pancreatic trauma: what's new? *Eur J Trauma Emerg Surg*. 2015; 41: 239-50. doi: 10.1007/s00068-015-0510-3.

11. Fulcher AS, Turner MA, Yelon JA, et al. Magnetic resonance cholangiopancreatography (MRCP) in the assessment of pancreatic duct trauma and its sequelae: preliminary findings. *J Trauma*. 2000 Jun;48(6):1001-7. doi: 10.1097/00005373-200006000-00002.

12. Moore EE, Cogbill TH, Malangoni MA, et al. Pancreas, duodenum, small bowel, colon, and rectum. *J Trauma*. 1990;30:1427–9.

13. Wolf A, Bernhardt J, Patrzyk M, Heidecke CD. The value of endoscopic diagnosis and the treatment of pancreas injuries following blunt abdominal trauma. *Surg Endosc*. 2005 May;19(5):665-9. doi: 10.1007/s00464-003-9276-5. Epub 2005 Mar 11.

14. Canty TG Sr, Weinman D. Management of major pancreatic duct injuries in children. *J Trauma*. 2001 Jun;50(6):1001-7. doi: 10.1097/00005373-200106000-00005. PMID: 11428378.

15. Garvey EM, Haakinson DJ, McOmber M. Role of ERCP in pediatric blunt abdominal trauma: a case series at a level one pediatric trauma center. *J Pediatr Surg*. 2015 Feb;50(2):335-8. doi: 10.1016/j.jpedsurg.2014.08.017. Epub 2014 Dec 23.

16. Houben CH, Niyi Ade-Ajayi N, Shailesh Patel S, et al. Traumatic pancreatic duct injury in children: minimally invasive approach to management. *J Pediatr Surg*. 2007 Apr;42(4):629-35. doi: 10.1016/j.jpedsurg.2006.12.025.

17. Jobst MA, Canty TG Sr, Lynch FP. Management of Pancreatic Injury in Pediatric Blunt Abdominal Trauma. *J Pediatr Surg*. 1999 May;34(5):818-23; discussion 823-4. doi: 10.1016/s0022-3468(99)90379-2.

18. Wood JH, Partrick DA, Bruny JL, et al. Operative vs nonoperative management of blunt pancreatic trauma in children. *J Pediatr Surg*. 2010 Feb;45(2):401-406. PMID: 20152361 DOI: 10.1016/j.jpedsurg.2009.10.095

19. Ordoñez CA, Parra MW, Millán M, et al. Damage control in penetrating duodenal trauma: less is better - the sequel. *Colomb Med (Cali)*. 2021 May 3;52(2):e4104509. doi: 10.25100/cm.v52i2.4509.

20. Ordoñez CA, Parra M, Caicedo Y, et al. REBOA as a New Damage Control Component in Hemodynamically Unstable NTCH patients. *Colomb Med (Cali)*. 2020; 51(4): e204506.

21. Ball CG, Correa-Gallego C, Howard TJ, et al. Damage Control Principles for Pancreatic Surgery. *J Gastrointest Surg*. 2010; 14: 1632-3. doi: 10.1007/s11605-010-1286-8.

22.Ordoñez CA, Parra MW, Millán M, et al. Pancreatic damage control: the pancreas is simple don't complicate it. *Colomb Med (Cali)*. 2020 Dec 30;51(4):e4164361. doi: 10.25100/cm.v51i4.4361

23. Feliciano DV, Martin TD, Cruse PA, et al. Management of combined pancreatoduodenal injuries. *Ann Surg*. 1987;205:673–80.

24. Asensio JA, Petrone P, Roldán G, Kuncir E, Demetriades D. Pancreaticoduodenectomy: A rare procedure for the management of complex pancreaticoduodenal injuries. *J Am Coll Surg*. 2003; 197(6):937-42. doi: 10.1016/j.jamcollsurg.2003.07.019.

25. Coccolini F, Kobayashi L, Kluger Y, et al. Duodeno-pancreatic and extrahepatic biliary tree trauma: WSES-AAST guidelines. *World J Emerg Surg*. 2019; 14: 56. doi: 10.1186/s13017-019-0278-6

26. . Vaughan GD III, Frazier OH, Graham DY, et al. The use of pyloric exclusion in the management of severe duodenal injuries. *Am J Surg*. 1977;134:785–90.

27. Seamon MJ, Pieri PG, Fisher CA, et al. A ten-year retrospective review: does pyloric exclusion improve clinical outcome after penetrating duodenal and combined pancreaticoduodenal injuries? *J Trauma*. 2007;62:829–33.

JC, BM, , et al. Is there a role for pyloric exclusion after severe duodenal trauma? *Rev Col Bras Cir*. May-Jun 2014;41(3):228-31.

29. Velmahos GC, Constantinou C, Kasotakis G. Safety of repair for severe duodenal injuries. *World J Surg*. 2008 Jan;32(1):7-12. doi: 10.1007/s00268-007-9255-4.

30. DuBose JJ, Inaba K, Teixeira PG, et al. Pyloric exclusion in the treatment of severe duodenal injuries: results from the National Trauma Data Bank. *Am Surg*. 2008 Oct;74(10):925-9. doi: 10.1177/000313480807401009.

31. Fang JF, Chen RJ, Lin BC, et al. Retroperitoneal laparostomy: an effective treatment of extensive intractable retroperitoneal abscess after blunt duodenal trauma. *J Trauma*. 1999;46:652–5.