What Is the Optimal Management of Traumatic Duodenal Injury?

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Introduction

Diagnostic and management challenges of injuries to the most distal section of the foregut have been discussed in the literature for over a century. Herczel was the first surgeon to describe repairing a blunt duodenal injury in 1896 [1]. This was followed by Summers' 1904 description of the repair of a penetrating duodenal injury [2]. An abundant, but unfortunately scientifically thin literature has followed. The difficulty ascribed to duodenal injuries results from their association with concurrent intra-abdominal injuries, technical challenges to operative management, and their scarcity.

In 68–86.5% of traumatic duodenal injuries a coexisting intra-abdominal injury is found [3–5]. In 50–55% of cases there is an associated colonic injury [4, 6]. An additional 23–40% of patients will have a major vascular injury with lesions to the inferior vena cava most frequently described [3, 5]. Associated injuries contribute to the high overall mortality of patients with duodenal injuries (11.1–16.7%) [6–8].

Duodenal injuries are found in only 3–5% of traumatic abdominal injuries [8]. The majority of duodenal trauma is penetrating. 79–80% of duodenal injuries result from gunshot wounds to the abdomen [2, 4]. The most frequently injured aspect of the duodenum is the second, or descending portion, which is found injured in 35% of cases [9, 10]. This scarcity precludes individual surgeons from acquiring expertise and researchers from adequately powering studies evaluating the optimal management of traumatic duodenal injuries.

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Table 21.1 AAST grading scale for duodenal trauma

	Description
Grade I	Hematoma involving single portion of the duodenum OR Laceration that is partial thickness without perforation
Grade II	Hematoma involving more than one portion of the duodenum OR Laceration that disrupts <50% of the circumference
Grade III	Laceration that disrupts 50–75% of the circumference of D2 OR laceration that disrupts 50–100% of the circumference of D1, 3–4
Grade IV	Laceration that disrupts >75% of D2 OR involves the ampulla or distal CBD
Grade V	Laceration that involves "massive" disruption of the pancreaticoduodenal complex OR Vascular injury resulting in devascularization of the duodenum

Table adapted from Moore et al. (1990) with permission from Wolters Kluwer Health, Inc. [11]

To standardize the description of duodenal injuries and facilitate their research the American Association for the Surgery of Trauma created the Organ Injury Severity Scale (AAST OIS) for duodenal injuries (Table. 21.1). The AAST OIS has allowed for surgeons to speak a common language when describing duodenal injuries; however, the optimal way to manage these different injuries is often individualized and nuanced. This chapter will attempt to synthesize the available data and expert opinion to guide the management of this complex injury pattern.

Search Strategy

A search of publications indexed on PubMed, PubMed Central, and Medline from 2010 to 2020 was used to identify published data on management of traumatic duodenal injuries. Search terms used included "duodenal trauma," "duodenum," "trauma," "pyloric exclusion," and "trauma pancreaticoduodenectomy." Studies were excluded if the primary language was not English, or if they focused predominantly on a pediatric patient population, on pancreatic injuries, or if they did not provide information regarding their studied population or other relevant clinical information. Additional publications were identified through a snowball methodology from the initially identified publications.

The initial query identified 1141 references. Following analysis of abstracts and exclusion of non-English articles, articles focusing on injuries from ERCP, and articles focused on a pediatric population, 47 articles were identified. This was narrowed to 34 articles with sufficient scope for in-depth review (Table 21.2).

Results

Imaging

In the hemodynamically stable patient, a CT scan is the gold standard for imaging identifying duodenal injuries. CT imaging has only a 70% sensitivity for diagnosing

Table 21.2 PICO review process for duodenal trauma

Population	Adult patients with duodenal trauma
Intervention	Primary repair
Comparison	Non-operative management, Berne procedure, triple tube decompression, pyloric exclusion, Pancreaticoduodenectomy
Outcomes	Mortality, intra-abdominal sepsis, leak rate, hospital length of stay, ICU length of stay

blunt duodenal injury at the time of initial presentation; however, it remains an important adjunct to the evaluation of the traumatic patient [12]. CT imaging that demonstrates extraluminal contrast in the area of the duodenum warrants emergent exploration. This finding is seldom encountered as intraluminal contrast is not frequently administered in the acute trauma evaluation. Twenty-one percent of patients with the findings of peri-duodenal hematoma and/or peri-duodenal fluid collections who have exploratory laparotomies require operative intervention on their duodenal injuries [13]. Patients with these soft findings—peri-duodenal hematoma and peri-duodenal fluid collection—on imaging should be evaluated in the context of the individual patient to determine if operative intervention is indicated.

Duodenal Hematoma

Morbidity from AAST-OIS Grade I or Grade II duodenal hematomas can result from gastric outlet obstruction. These may be found in blunt abdominal trauma patients on CT imaging. In the absence of concurrent injuries in a hemodynamically stable patient, these hematomas may be managed non-operatively. Non-operative management may be guided by nasogastric tube decompression and serial abdominal exams. If the patient remains NPO 7 days after presentation, parenteral nutrition should be considered. This non-operative management will fail in 5–10% of patients, however, is not associated with any differences in length of stay [5, 12, 13].

If gastric outlet obstruction persists for greater than 14 days, procedural intervention can be considered. These hematomas can be resolved via drainage by interventional radiology, through laparoscopic drainage, or drainage with primary repair following laparotomy [5, 13–16]. CT guided catheters placed in interventional radiology have been described in cases of pediatric trauma [15]. Laparoscopic drainage may be conducted with a needle that is inserted under direct visualization into the hematoma to allow for drainage.

Historical Procedures

Initially, it was believed that duodenal injuries required extensive repairs due to the high acidity and volume of effluent passing through the duodenum. Complex techniques such as Berne's diverticulization of the duodenum (antrectomy with vagotomy,

oversewing of duodenal stump and then performing a gastrojejunostomy) and the Triple Tube Decompression technique described by Stone and Fabian (repair with a nasogastric tube, retrograde jejunostomy for decompression, and anterograde jejunostomy for feeding) were described as surgeons attempted to protect their repairs [14, 17]. These techniques were believed to be successful and necessary. The triple tube decompression technique had excellent single-center outcomes. However, these successes have not been able to be replicated at other institutions. While these techniques are still used in some institutions, the advent of proton pump inhibitors assuaged concerns of exposing duodenal repairs to the acidity of gastric fluids [17–19].

Pyloric Exclusion

First described by Lewisohn in 1918 the pyloric exclusion is a popular, simple technique that is used to protect a duodenal repair in 19.2% of operative interventions for duodenal trauma [8, 20]. The gastric pylorus is either stapled across, or a gastrotomy is made and an absorbable purse-string is placed to occlude the lumen of the pylorus. This is commonly followed by a Billroth-2 reconstruction in which a proximal loop of jejunum is apposed in an antecolic position, identical incisions are made on the jejunum and approximated stomach and then closed with a running layer of full thickness absorbable suture and covered with an anterior serosal layer of interrupted silk sutures [21]. Endoscopic studies have demonstrated that within 3 weeks the pylorus will have opened [22]. While theoretically sound, patients who have a pyloric exclusion have no survival benefit, tend more likely to have postoperative complications, and have longer hospital lengths of stay (22.2–32.2 days, $p = 0.003$) [20, 22].

Primary Repair

Given the lack of reproducible improved efficacy of complex repairs, and the unclear benefit of pyloric exclusion, current practice suggests a primary suture repair of the duodenum. Primary suture repair of a duodenal injury is the most utilized technique in the management of duodenal trauma. Primary repair was performed in 78.5% of all repairs in the U.S. between 2002 and 2014, and subset analysis shows that it is becoming more prevalent over time [8]. Accruing data on primary repair demonstrates no difference in mortality, duodenal leak rate, and intra-abdominal sepsis rate versus more complex techniques [5, 14, 23–25]. Interestingly the only difference between primary repair and a reconstruction including a gastrojejunostomy is shorter length of stay for patients who receive a primary repair [24]. This difference in LOS without a change in mortality or morbidity persists even when evaluating only AAST OIS grade IV/V injuries [24].

Drain Placement

A recently repaired duodenal injury may have a drain placed alongside the repair. This recommendation runs against the grain of Schroeppel et al.'s observation that patients who develop a duodenal leak are more likely to have an extraluminal closed suction drain in place following their repair (90 vs. 45%; $p = 0.008$) [10]. Despite its statistical significance, this data is observational and does not adequately consider the contexts in which surgeons would choose whether a drain is indicated (concurrent liver, gastric, pancreatic, or renal injuries).

Pancreaticoduodenectomy

Unless the injury is so massive as to make a less complex repair technically impossible, a pancreaticoduodenectomy (Whipple procedure) in the acute trauma patient should be avoided [5, 14]. Complete disruption of the pancreaticoduodenal complex requires this resection and reconstruction, but it should be avoided when possible. There has been no demonstrated benefit in terms of mortality, ICU days, and hospital length of stay for patients who underwent pancreaticoduodenectomy relative to a less complex repair [26]. Patients who undergo a pancreaticoduodenectomy for traumatic injuries have a reported 13–33% mortality rate [3, 27–30]. When no other alternative than a pancreaticoduodenectomy exists, the operating surgeon should strongly consider performing the procedure in stages and, in consideration of the surgeon's comfort level, with the assistance of a hepatobiliary specialist.

A single-stage pancreaticoduodenectomy for traumatic injuries takes an additional 4 h to complete (460 min compared to 243) compared to a damage control surgery [28]. Patients who receive pancreaticoduodenectomy at time of index operation are also more likely to develop an enterocutaneous fistula (67 vs. 8%; $p = 0.04$) and intra-abdominal sepsis (100 vs. 17%) than patients who have damage control surgery prior to a staged pancreaticoduodenectomy [28]. The centers that have the best-reported outcomes with pancreaticoduodenectomies for traumatic etiologies emphasize their highly selective approach to the procedure and their preference to perform the procedure in multiple stages [28, 29].

Enteric Feeding

Patients with severe duodenal injuries can quickly become malnourished. If patients with AAST OIS grade I or II injuries remain NPO 7 days after presentation, parenteral nutrition should be considered. Patients with severe (grade IV–V) duodenal injuries will require TPN in 37–75% of cases [5]. This persists regardless of the placement of a jejunostomy feeding tube at time of operation, as 75% of patients

who undergo a triple tube decompression procedure will demonstrate jejunal tube feeding intolerance when fed within 14 days of their operation [31].

Imaging Surveillance

Follow-up imaging to evaluate a duodenal repair should not be scheduled but should be guided by a patient's clinical symptoms [5]. If a patient develops symptoms concerning for an ileus, obstruction, or enteric leak a CT scan with PO and IV contrast is indicated for further evaluation.

Recommendations Based Upon the Data

1. Hemodynamically stable patients with AAST Grade I and II duodenal injuries should be managed non-operatively (evidence quality moderate; moderate recommendation).
2. Whenever technically able Grade III–V duodenal injuries should be managed with primary repair.
3. Pyloric exclusion increases hospital length of stay and should be avoided (evidence quality moderate, moderate recommendation).
4. Pancreaticoduodenectomy should only be performed when a primary repair of a duodenal injury is technically impossible to achieve (evidence quality low; moderate recommendation).

A Personal View

Despite the scarcity of traumatic duodenal injuries, we continue to accrue data that guide their optimal management. We have learned that blunt trauma patients with low grade (I and II) injuries can be mostly managed non-operatively with supportive care. Laparotomy can often be avoided in the blunt trauma patient, and multiple non-operative or less invasive techniques are present to ameliorate persistent duodenal hematomas. In higher grade or penetrating trauma mechanisms, we have found that despite the theoretical appeal of complex operations, primary repair of these injuries remains equally if not more effective at preventing further morbidity for the patient. Primary repair and/or segmental resection of distal duodenal injuries with primary anastomosis and without pyloric exclusion is safe and often preferable. In short, the simplest answer in the case of duodenal repairs is often correct.

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