Penetrating duodenal trauma: A 19-year experience

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BACKGROUND: Multiple techniques are used for repair in duodenal injury ranging from simple suture repair for low-grade injuries to pancreaticoduodenectomy for complicated high-grade injuries. Drains, both intraluminal and extraluminal, are placed variably depending on associated injuries and confidence with the repair. It is our contention that a simplified approach to repair will limit complications and mortality. The major complication of duodenal leak (DL) was the outcome used to assess methods of repair in this study.

METHODS: After early deaths from associated vascular injuries were excluded, patients with a penetrating duodenal injury admitted during a 19-year period ending in 2014 constituted the study population.

RESULTS: A total of 125 patients with penetrating duodenal injuries were included. Overall, the leak rate was 8% with two duodenal-related mortalities. No differences were seen in patients who had a DL as compared with no leak with respect to demographics, injury severity, or admission variables. Patients with DL were more likely to have a major vascular injury (60% vs. 23%, $p = 0.02$) and a combined pancreatic injury (70% vs. 31%, $p = 0.03$). No differences were identified by repair technique, location, or grade of injury. DLs were more likely to have an extraluminal drain (90% vs. 45%, $p = 0.008$).

CONCLUSION: Primary suture repair should be the initial approach considered for most injuries. Major vascular injuries and concomintant pancreatic injuries were associated with most leaks; therefore, adjuncts to repair including intraluminal drainage and pyloric exclusion should be considered on the initial operation. Extraluminal drains should be avoided unless required for associated injuries. (*J Trauma Acute Care Surg.* 2016;80: 461–465. Copyright © 2016 Wolters Kluwer Health, Inc. All rights reserved.)

LEVEL OF EVIDENCE: Therapeutic/care management study, level IV.

KEY WORDS: Trauma, duodenum, penetrating.

Traumatic injury to the duodenum is uncommon, occurring in less than 5% of abdominal injuries.[1] The duodenum is located in a protected position in the retroperitoneum; however, it is also adjacent to major systemic and splanchnic vascular structures, biliary structures, and the pancreas. Techniques for repair include simple suture repair, repair and intraluminal decompression, duodenal diverticulization, pyloric exclusion (PE), and pancreaticoduodenectomy for the most destructive injuries.[2–5] Contemporary literature emphasizes simple repair of the duodenum, with complicated repairs reserved for more severe injuries.[2,6–9] We evaluated our results to repair duodenal injuries over a 19-year study period.

PATIENTS AND METHODS

The study was conducted at the Presley Regional Trauma Center at the Regional Medical Center in Memphis, Tennessee.

Patients were identified by query of the trauma registry for duodenal injuries from January 1, 1996, to December 31, 2014. Injuries were graded based on the American Association for the Surgery of Trauma organ Injury Severity Scale (ISS).[10] Grade I includes hematoma involving a single portion, partial thickness, no perforation. Grade II includes hematoma involving more than one portion, disruption of less than 50% circumference. Grade III includes disruption of 50% to 75% circumference of D2 or 50% to 100% of D1, D3, or D4. Grade IV includes disruption of 75% of D2 or involving ampulla or distal common bile duct. Grade V includes massive disruption of the duodenal pancreatic complex or devascularization of the duodenum.[10]

Exclusion criteria included death within 24 hours of admission, blunt mechanism, and injuries (Grade I) that did not require repair. Patients were stratified based on demographics, transfusions, admission blood pressure, admission base deficit, initial repair technique, injury severity, and associated injuries. The primary outcome was duodenal leak (DL) rate. Secondary outcomes included in-hospital mortality, morbidity, and hospital length of stay (LOS).

Definitions

Time to operating room (OR) was defined as the time interval from arrival in the resuscitation room to arrival in the OR. Major abdominal vascular injuries included injuries to the portal vein, the inferior vena cava, or the aorta. Acute kidney injury was defined as an elevation of 50% from the baseline creatinine. Abscess was defined as any rim enhancing collection seen on contrast-enhanced imaging. Ventilator-associated pneumonia was diagnosed by bronchoalveolar lavage of equal to or greater than 10^5 colony-forming units per milliliter on quantitative culture of the effluent. DL was defined as operative confirmation of a leak or contrast study showing extravasation from the duodenum.

Statistical Analysis

Statistical comparison was performed comparing DL to no DL using Student's *t* test for continuous variables and χ^2 or Fisher's exact test for categorical variables where appropriate. All statistical analysis was performed using SAS version 9.2 (SAS Institute, Cary, NC). A p value of less than 0.05 was considered significant.

The University of Tennessee Health Science Center and the Regional Medical Center institutional review boards approved this study.

RESULTS

A total of 212 patients with duodenal injuries were identified during the 19-year study period. Eighty-seven patients were excluded from the analysis (34 blunt injures, 35 because of death in the first 24 hours, and 18 Grade I injuries). Of the remaining 125 patients, the mean age was 31 years, with 90% of them male. Locations of the duodenal injury included 8% in the first portion, 35% in the second, 14% in the third, 17% in the fourth, and 26% had injuries in multiple locations. Overall, the DL rate was 8% with two duodenal-related mortalities.

Comparison of patients with DL with those without yielded no differences in demographics, injury severity, or admission variables (Table 1). Patients with DL were more likely to develop an abscess (50% vs. 17%, $p = 0.03$). DL patients also had longer LOS and higher mortality, but these differences did not reach significance (Table 2). There were significantly more pancreatic injuries (70% vs. 31%, $p = 0.03$) and major abdominal vascular injuries in the DL cohort (60% vs. 23%, $p = 0.02$).

TABLE 1. Demographics and Injury Severity Comparing DL and No DL

	Total	DL	No DL	
	(n = 125)	(n = 10)	(n = 115)	*p*
Age, y	31 (21–39)	27 (19–42)	32 (21–39)	0.27
Male, %	90	100	89	0.60
ISS	20 (11–25)	23 (17–25)	20 (10–25)	0.42
Transfusions	9.1 (0–10.5)	9.8 (2–28)	9.0 (0–10)	0.88
Admission SBP, mm Hg	119 (96–140)	139 (128–176)	118 (96–140)	0.19
BD	5.1 (7.7–3.4)	4.8 (5.5–2.6)	5.1 (8.0–1.1)	0.88
Time to OR, min	37 (20–42)	38 (22–50)	37 (20–40)	0.94

Continuous variables expressed as median (IQR). Categorical variables expressed as percentage.
BD, base deficit; IQR, interquartile range; transfusions, transfusions in first 24 hours.

No differences were found in injury grade or repair technique between the two groups (Table 3). While no differences in DL rate by repair type were found, patients who developed a DL were more likely to have an extraluminal closed suction drain (90% vs. 45%, $p = 0.008$). The majority of leaks occurred with injuries in the second portion and 7 of the 10 DLs had associated pancreatic injuries. Patient 6 had a medial wall injury with associated injury to the head of the pancreas that was treated with biliary diversion (cholecystojejunostomy) and drainage. Patient 9 had an associated injury to the head of the pancreas and developed multiple antibodies during transfusions. Ultimately, no blood was available despite a nationwide search. Bovine stabilized hemoglobin-based oxygen carrying solution was given on a compassionate basis, but he succumbed to exsanguination and anemia. Patient 10 had an associated injury to the proximal ureter that resulted in a fistula to the duodenum. This leak healed following operative repair and nephrectomy. The other duodenal-related mortality occurred in Patient 7. An associated pancreatic injury and leak resulted in massive inflammation and eventual mortality related to adult respiratory distress syndrome. The majority of leaks resolved with either initial drains (3 of 10) placed for combined pancreatic injury or operative diversion/drainage (5 of 10).

DISCUSSION

Injuries to the duodenum continue to be difficult to manage, with contemporary series reporting cumulative mortality of 16%, morbidity of 40%, and a DL rate of 6.2% (range, 0–33%).[1–3,11–18] For penetrating duodenal injuries, many authors are currently recommending primary repair, with more complex repairs reserved for more severe injuries.[2,6,9,15] Our results support that approach. The majority of the patients in the current study underwent primary repair with or without intraluminal drainage with a comparable DL rate of 8%. Controversy still exists in the cohort of patients with more severe injury Grades III to V and injuries located in the second portion (especially medial wall). Reported adjuncts to primary repair include the duodenal "diverticulization" procedure as described by Berne et al.[4] This approach has been largely abandoned because of the additional length and complexity of the procedure and the removal of healthy tissue. Lateral tube duodenostomy, a component of the "diverticulization" procedure, may be a helpful adjunct after a leak occurs but should not be performed at the initial procedure. PE to divert the luminal contents in tenuous repairs as described by Vaughan et al.[5] continues to be a viable option. This approach involves primary repair of the injury with opening of the stomach and suture or staple closure of the pylorus followed by a gastrojejunostomy. Several authors have not found any difference in terms of DL rates and actually have associated a higher morbidity with PE.[8,9,15] The results of the current study also did not find any differences between primary suture repair, suture repair with intraluminal drain, or PE. When interpreting the results of the study, Grade II injuries should be repaired primarily without any adjuncts. Intraluminal drains were likely overused during the study period in patients with Grade II injuries. The use of this technique should be limited to tenuous repairs without a "medial wall" component of the second portion in patients with Grade III injuries. Grade III injures involving the first, third, or fourth portions of the duodenum can likely undergo primary repair alone. Second portion injuries with minimal medial wall component can be managed with repair and intraluminal drains. If a significant amount of the medial wall of the second portion is involved, then PE should be performed at the initial operation. Patients with combined pancreatic and duodenal injuries were at high risk for DL in the current study and deserve special consideration. More than two thirds of the leaks in this study were associated with a pancreatic injury. PE at the initial operation should be considered for these combined injuries and injuries with a large "medial wall" component in the second portion. In other injuries to the second portion, triple-tube drainage as described by Stone and Fabian continues to be used as an adjunct

TABLE 2. Outcomes Comparing DL and No DL

	DL	No DL	
	(n = 10)	(n = 115)	*p*
Abscess (%)	50	17	0.03
Acute Kidney Injury (%)	30	11	0.12
Pneumonia (%)	30	16	0.37
LOS (Days)	48 (33, 72)	25 (10, 31)	0.07
Mortality (%)	20	11	0.34

Continuous variables expressed as median (IQR). Categorical variables expressed as percentage.

TABLE 3. Repair Technique Comparing DL With No DL

		Primary Repair	Afferent/Efferent Tubes	PE	PD
		1/46	6/63	3/13	0/3
Grade	n	(2.1%, $p = 0.09$)	(9.5%, $p = 0.75$)	(23.1%, $p = 0.07$)	(0%, $p = 0.99$)
II	69	35*	32*	2	0
III	49	9	31*****	9*	0
IV	4	2	0	2**	0
V	3	0	0	0	3

*Each demonstrates a leak (n = 10). *p* for comparisons of repair techniques between DL and no DL.
PD, pancreaticoduodenectomy.

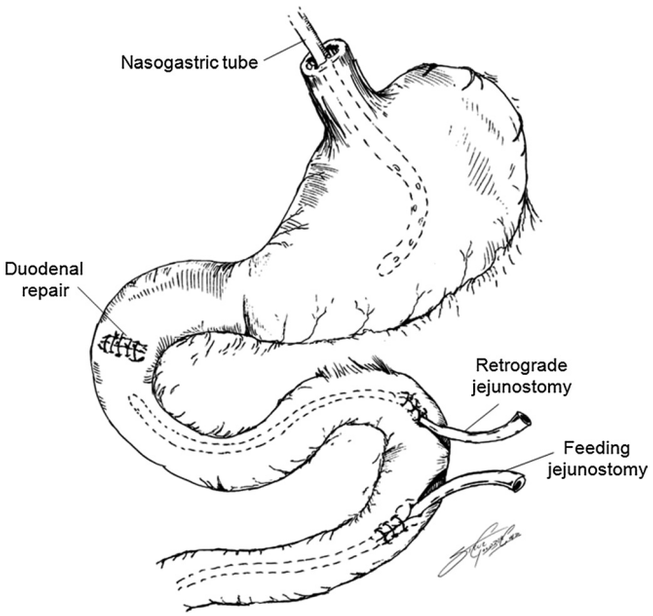

Figure 1. Cartoon demonstrating duodenal repair and triple-tube drainage.

at our institution. Ivatury et al.[19] have found increased morbidity including complications from the jejunostomy site (obstruction and dislodged tube) and have recommended that this technique be abandoned. However, we believe that decompression of the 2 L to 3 L of bile and pancreatic secretions produced daily reduces the risk for suture line failure; intraluminal pressure is lowered, and these highly digestive materials are contained if a small leak develops. We continue to use the triple-tube technique as our go-to management technique in the absence of a complicated pancreatic head injury or a medial wall component (Fig. 1).

A notable finding of the current study was that most patients who developed a DL had an extraluminal drain. Although often difficult to determine in this retrospective analysis whether the drain was placed for an associated pancreatic injury, hepatic injury, or for a tenuous repair, extraluminal drains were associated with DL. Velmahos et al.[20] also noted that finding, with 80% of DL associated with an extraluminal drain. We now believe drains should be avoided unless treating an associated pancreatic injury.

The main limitations of the study include its retrospective nature and the 19-year interval. Changes in practice patterns and advance in other aspects of care could impact the results. Injury location and grade of injury were also variably described in the operative records. Where data were limited in the records, consensus of the authors was used for grade and location, which could impact the accuracy of these classifications.

CONCLUSIONS

Primary suture repair of duodenal injuries should be the initial approach considered in most situations. Adjuncts including intraluminal drainage should be reserved for tenuous repairs primarily for injuries in the second portion without a medial wall component; PE should be considered at the initial operation in patients with a combined pancreatic head and duodenal injury or a medial wall component in the second portion. Extraluminal drains should be avoided unless treating an associated pancreatic injury. Injury to the duodenum continues to be a challenge to diagnose and treat, but simplifying management can ease decision making and maintain an acceptable DL rate.

AUTHORSHIP

T.J.S. performed the literature search. T.J.S., P.E.F., and T.C.F. provided the study design. T.J.S. and K.S. performed the data collection. T.J.S., P.E.F., J.P.S., L.J.M., J.A.W., M.A.C., and T.C.F. performed the data analysis/interpretation. T.J.S. drafted the manuscript. T.J.S., M.A.C., T.C.F., J.P.S., and L.J.M. provided critical revision/final approval.

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DISCLOSURE

The authors declare no conflicts of interest.

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