Duodenal injuries: how to deal with it?

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Objective
The aim of this study was to report on a series of nine cases of duodenal repairs using different modalities and to describe reported complications or improvements in clinical outcomes among patients with complex duodenal trauma.

Patients and methods
This was a cross-sectional study conducted on nine cases of duodenal repairs using different modalities. A total of 50 patients with penetrating or blunt abdominal trauma and duodenal injury were admitted to the emergency department of Minia University Hospital between March 2012 and December 2014. All of the known cases of duodenal trauma among these patients were reviewed.

Results
The mean age of the patients was 35.2±10.9 years. The time elapsed from admission to the surgical intervention ranged from 20 min to 10 h, and the median time was 90 min. Postoperative complications were common and occurred in five patients. Length of hospital stay ranged from 7 to 90 days and the median length was 17 days. Primary repair, segmental resection, primary end-to-end duodenoduodenostomy, duodenal diverticulization, direct anastomosis of Roux-en-Y over the injury in an end-to-side manner, and pancreaticoduodenectomy were performed on the basis of the condition of the cases.

Conclusion
Most duodenal injuries can be managed by means of simple repair. More complicated injuries need more sophisticated operation techniques and are followed by a high incidence of postoperative complications, especially duodenal fistula and high mortality.

Keywords:
duodenal, injuries, Minia

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Introduction

Because of its retroperitoneal location, injuries to the duodenum are relatively uncommon, occurring in only 3–5% of all abdominal injuries [1,2].

The majority of duodenal injuries are caused by penetrating trauma that requires immediate exploratory laparotomy. Blunt injury is infrequent but difficult to diagnose because of its vague clinical symptoms and signs. It has been reported that the second portion of the duodenum is injured most commonly, approximately in one-third of the cases reported [3].

The anatomy of the duodenum is unique and complex because of its close relationship with adjacent structures. Lying deep within the abdomen, the duodenum is well protected in the retroperitoneal space. Duodenal trauma has the following clinical characteristics:

(a) Low diagnostic accuracy before operation, with the rate of definite diagnosis before operation always below 10% [4];
(b) Presence of other injuries, due to the special and complicated anatomy of the duodenum;
(c) High incidence of missed diagnosis during operation, which can reach 20% [5]; and
(d) High incidence of postoperative complications and mortality rate, which can reach as high as 50% [6].

Abdominal plain films, ultrasound test, and CT scan can also help in the diagnosis of duodenum injury. Retroperitoneal air, free intraperitoneal air, or other signs such as obliteration of the psoas muscle shadow and scoliosis of the lumbar vertebrae can give a clue of injury [7]. Serum amylase is elevated in 50% of patients with duodenal or upper gastrointestinal injury [8].

The vast majority of duodenal injuries can be managed by means of simple repair [2]. Repair of multiple or delayed injuries often presents a technical challenge, and a variety of techniques have been described. The use of duodenal diversion through gastrojejunostomy was originally conceived in the early 1900s [9], but the

simplified technique of pyloric exclusion was devised by Jordan and was first reported by Vaughan *et al.* in 1977 [10].

This procedure consists of primary repair of the duodenal wound, closure of the pylorus through gastrotomy, and gastrojejunostomy at the site of the gastrostomy. Pyloric exclusion has been recommended in selected patients with complicated duodenal injury because it decreases the morbidity associated with dehiscence and fistula formation. However, the current philosophy for the management of pancreaticoduodenal injuries is that less treatment is probably the best treatment [11].

Table 1 Duodenal injury according to the American association for the surgery of trauma

Grade	Injury	Description
I	Hematoma	Single portion of duodenum
	Laceration	Partial thickness only
II	Hematoma	Involving more than one portion
	Laceration	Disruption of <50% of circumference
III	Laceration	Disruption of 50–70% of the circumference of D2
		Disruption of 50–100% of the circumference of D1, D3, and D4
IV	Laceration	Disruption of >75% of the circumference of D2 involving the ampulla of distal common duct
V	Laceration	Massive disruption of the duodenopancreatic complex
	Vascular	Devascularization of the duodenum

Objective

The purpose of this study was to report on a series of nine cases of duodenal repairs using different modalities and to describe reported complications or improvements in clinical outcomes among patients with complex duodenal trauma.

Patients and methods

This was a cross-sectional study conducted on nine cases of duodenal repairs using different modalities. A total of 50 patients with penetrating or blunt abdominal trauma and duodenal injury were admitted to the emergency department of Minia University hospital between March 2012 and December 2014. All of the known cases of duodenal trauma among these patients were reviewed.

Institutional ethics committee approval was obtained. The data collected included demographics, sex, age, mechanism of injury, admission vital signs, time elapsed between injury and operation, the site and grade of duodenal injury, associated organ injuries, surgical procedure used, presence of complications (including duodenal fistula), and mortality. Duodenal injuries were classified on the basis of the American Association for the Surgery of Trauma – Organ Injury Scale (AAST-OIS) (Table 1) [12].

D1, D2, D3, and D4 are the first, second, third, and fourth portions of the duodenum, respectively. For multiple injuries, the grade is advanced by one [12].

For the operation, a midline incision was made. The first priority was to control life-threatening hemorrhage from vascular structures or parenchymatous organs, followed by controlling the sources of gastrointestinal spillage. The duodenum was explored and mobilized by means of a Kocher maneuver, a Cattell–Braasch maneuver, or both. The injuries were graded and surgical repair was dictated by the surgeon's judgment. The decision was based on the degree of duodenal injury, extent of multiple organ involvement, degree of edema and friability of the duodenum, time elapsed between injury and treatment, and the general condition of the patient.

If the range of duodenum injury is less than 50% of the circumference, with regular injury border, adequate blood supply, and without serious peritoneum pollution, the injury could be primarily closed transversely and the decompression of duodenum could be achieved by means of jejunostomy.

If the range of duodenum injury is more than 50% of the circumference, or primary closure of the defect may narrow the lumen of the bowel or result in undue tension and subsequent breakdown of the suture lines, segmental resection and primary end-to-end duodenoduodenostomy are advised, especially when the first, second, or third part of the duodenum is injured.

If a large part of the duodenum is lost, suture of two ends will be impossible without causing undue tension on the suture line. If a large tissue of the first part of the duodenum is lost, surgeries of duodenal diverticulization should be carried out, which include closure of the duodenal injury, gastric antrectomy with end-to-side gastrojejunostomy, tube duodenostomy, and generous drainage in the region of the duodenal repair.

Otherwise, if such injury is distal to the ampulla of Vater, closure of distal duodenum and Roux-en-Y duodenojejunostomy is appropriate. If the injury happens to the second part of the duodenum, because of the limited mobilization of this part, a direct anastomosis of Roux-en-Y over the injury in an end-to-side manner is appropriate. This method

can be also applied to other parts when the primary anastomosis is impossible. If the patient has massive peripancreatic hemorrhage, proximal pancreatic duct or ampullary injuries that preclude the possibility of reconstruction, pancreaticoduodenectomy should be applied. A right upper quadrant drain was placed in all nine patients. The minimum follow-up was 6 months.

Ethical approval

The title, aim, and plan of the study was discussed and approved as regards the ethics of research in the General Surgical Department, Minia Faculty of Medicine. Written, informed consent was obtained from all participants or their relevant.

Results

This study included nine male patients who were exposed to duodenal injury. The mean age of the patients was 35.2±10.9 years (range: 17–50 years). The causes of injury included motor car accident in three patients, blunt trauma in three patients, penetrating GSWs in one patient, motor bike accident in one patient, and pathological perforation of duodenal ulcer in one patient. The mean systolic blood pressure on admission was 113±18 mmHg. The time elapsed from admission to the surgical intervention ranged from 20 min to 10 h and the median time was 90 min (Table 2).

One patient had grade V injuries and two patients had grade II injuries. Three patients had grade III and another three patients had grade I injuries. Associated abdominal injuries were identified in five patients and are listed in Table 2. Postoperative complications were common and occurred in five patients. Length of hospital stay ranged from 7 to 90 days and the median length was 17 days (Table 3).

In the first and third cases, the range of duodenal injury was less than 50% of the circumference of D3 and so they were managed with primary repair. Partial thickness laceration of D3, D1, and D4 was found in sixth, seventh, and eighth cases, respectively, and they were also managed through primary repair.

More than 50% of D3 was lacerated in fifth case and so segmental resection and primary end-to-end duodenoduodenostomy was carried out. In ninth case, the large tissue of D1 was lost and duodenal diverticulization was performed. The injury happened to the second part of the duodenum in the fourth case and direct anastomosis of Roux-en-Y over the injury in an end-to-side manner was appropriate. Massive peripancreatic hemorrhage with ampullary

Table 2 Summary of patients

Patient number	Mechanism	Time elapsed between admission and surgery	Grade of injury	Associated abdominal injuries
1	Motor car accident	4 h	II	No
2	Motor bike accident	10 h	V	Common bile duct, pancreas
3	Motor car accident	1 h	II	Mesentery of small intestine
4	Motor car accident	45 min	III	Liver
5	Gunshot wound	20 min	III	No
6	Blunt	1 h	I	Injury of transverse colon
7	Pathological perforation of duodenal ulcer	2 h	I	No
8	Blunt	90 min	I	Stomach
9	Blunt	3 h	III	No

Table 3 Postoperative complications and outcome

Patient number	Complications	Reoperation	LOS	Survival
1	None	No	7	Yes
2	Wound infection and burst abdomen, pancreatic and biliary fistula	Reanastomosis of the gall bladder and the jejunum	90	Yes
3	None	No	15	Yes
4	Wound infection, bile discharge, duodenal fistula	Removal of liver pack after 48 h	28	Yes
5	Vomiting after 1 week from the operation	Refashioning of the gastrojejunal anastomosis	30	Yes
6	Burst abdomen	Closure of colostomy after 3 months	10	Yes
7	None	No	8	Yes
8	Wound infection	No	17	Yes
9	None	No	20	Yes

LOS, length of stay.

injury had happened in the second case and pancreaticoduodenectomy was applied.

Discussion

The management of duodenal injuries remains controversial, and this field lacks a consensus as regards the optimal treatment. Approximately 70–85% of all duodenal injuries can be repaired safely by means of primary repair. Patients with severe duodenal injuries should be considered candidates for more complex duodenal repairs, such as duodenal diverticulization or pyloric exclusion. However, there is no clear definition on when these procedures should be indicated and which duodenal injuries should be considered severe [4,13].

In the present study, five cases of duodenal injury were managed through primary repair or serosal omental patch. Most injuries of the duodenum may be repaired by means of primary suture in one or two layers. The closure should be orientated transversely, if possible to avoid luminal compromise. Excessive inversion should be avoided. Longitudinal duodentomies may usually be closed transversely if the length of the duodenal injury is less than 50% of the circumference of the duodenum [14].

If there is a probability of primary closure that could compromise the lumen of the duodenum, there are several alternatives that can be employed: pedicled mucosal graft, using a segment of the jejunum or a gastric island flab from the body of the stomach, has been suggested as a method of closing large duodenal defects [15]. Another possibility is the use of a jejunal serosal patch to close the duodenal defect [16]. The clinical application of both of these methods is limited and suture line leaks have been reported [17].

In the ninth case, a large tissue of D1 was lost and duodenal diverticulization was performed. The main problem of duodenal diverticulization is that it is a time-consuming operation, and thus not recommended in hemodynamically unstable patients, or when several accompanied injuries are presented. A less formidable and less destructive alternative is the pyloric exclusion, which does not involve antrectomy, biliary diversion, or vagotomy [18]. Fang *et al*. [19] at Chang-Gung Memorial hospital in Taiwan described a technical method of controlled release of the pyloric exclusion knot, thereby timing the opening of the pyloric occlusion.

Massive peripancreatic hemorrhage with ampullary injury occurred in the second case and pancreaticoduodenectomy was applied. Snyder reported that ampullary injuries had an incidence of only 3% [20]. However, in a study by Asensio *et al*. [1], which included 170 patients who underwent pancreaticoduodenectomy in 50 reported series, the overall mortality rate reached 33%. Hence, pancreaticoduodenectomy should be applied carefully.

One biliary and another duodenal fistula have been developed. In the literature, duodenal fistula rates range from 0 to 16.2%, with an average incidence of 6.6% [21,2]. In a collective review of 15 series including 1408 patients with duodenal injuries, Asensio *et al*. [1,8] reported an average incidence of 6.6% for duodenal fistula.

Conclusion

Most duodenal injuries can be managed by means of simple repair. More complicated injuries need more sophisticated operation techniques and are followed by a high incidence of postoperative complications, especially the duodenal fistula and high mortality.

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Conflicts of interest

There are no conflicts of interest.

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