CASE REPORT

Isolated duodenal rupture: primary repair without diversion; is it safe? Review of literature

Muwaffaq Mezeil Telfah

Department of Surgery, Al
Jumhoori Teaching Hospital,
College of Medicine, University
of Mosul, Mosul City, Iraq

Correspondence to

Mr Muwaffaq Mezeil Telfah,
muwaffaqtelfah@yahoo.com

Accepted 30 March 2017

SUMMARY

Isolated duodenal rupture is a rare injury encountered among children following blunt abdominal trauma. Early diagnosis and treatment are essential to decrease the associated morbidity and mortality. The debate is about the optimum operative management. We report a 6-year-old child who presented with acute abdominal pain due to isolated duodenal injury following blunt abdominal trauma. Emergency laparotomy revealed duodenal rupture at the junction of the first and second part of duodenum and absence of any other visceral injuries. The duodenal injury was defined as grade III, that is, involving 75% of the circumference. We opted to perform primary repair of the injured duodenum in two layers alone without diversion. The abdominal cavity was drained using an open system drain next to the repair. Nasogastric and jejunostomy tubes were used postoperatively for gastric decompression and enteral feeding, respectively. The child had an uneventful recovery, was discharged well on the 10th postoperative day and no stenosis was found on long-term follow-up. The debate was whether to repair the defect primarily or to combine the repair with diversion. Early diagnosis, the isolated nature of the duodenal injury and the possibility of minimal contamination favoured primary repair of the defect without diversion. The good outcome attributed to these factors were in agreement with most of the literature.

BACKGROUND

Duodenal injuries are uncommon injuries encountered in abdominal trauma. They are usually associated with other visceral injuries following either penetrating or blunt trauma; however, isolated injuries of the duodenum are rare. We report a rare case of an isolated duodenal rupture in a 6-year-old child who was subjected to a sudden increase of intra-abdominal pressure following blunt trauma. The site of the rupture was at the junction of the first and second part of the duodenum which is the the most common site of injury after a sudden increase in intra-abdominal pressure. The operative management of duodenal injury represents a constant challenge for trauma surgeons due to late diagnosis of the injury and susceptibility of the duodenum to complications. There are controversies about the optimum operative treatment for isolated duodenal injury. The debate is about performing primary repair (PR) alone or doing a repair with diversion. The grade of the injury, the possibility of minimal

contamination and haemodynamic stability of our patient were in favour of PR of the duodenum alone without diversion. Moreover, the early presentation (within 6 hours of the trauma) together with early management was among the factors attributed to the good outcome. The aim of this article is to report this injury and to provide a review of the literature for isolated blunt duodenal injury and its treatment specific to the paediatric population. It also provides a brief interactive discussion about the mechanisms of duodenal injuries in general and specifically for this case.

CASE PRESENTATION

A 6-year-old boy complaining of severe abdominal pain was brought to the emergency department at midnight by his parents. A heavy object (an old-style big television box) fell from over a counter on the child. The parents saw the TV falling on the centre of the child's abdomen. There was no loss of consciousness, but the child complained of severe abdominal pain and associated vomiting later which contained food particles only but no blood. On arrival at the emergency department, the child was alert, pale and in severe pain; his pulse was 130 beats per min, blood pressure was 100/70 mm Hg, respiratory rate was 24 cycles per min, temperature was 37.1°C and oxygen saturation was 95% in air. Abdominal examination showed no bruises on the abdomen. There was severe tenderness in the right upper quadrant with signs of guarding and rigidity throughout the abdomen and upper abdominal distension. The vomit was inspected and was found to contain only food particles and no traces of blood. The child was healthy and no medical or surgical problems were identified in his medical history. He is not allergic to any medicines. He lived with his parents, two brothers and one sister. He had completed his immunisation schedule.

INVESTIGATIONS

Routine blood tests were taken and four units of blood were cross-matched. A focused abdominal sonography for trauma scan showed free fluid in the peritoneal cavity and specifically in the right upper quadrant, with a clear chest and pericardium. A chest X-ray showed a clear chest and no air under the diaphragm. A CT scan revealed fluid in *Morison's pouch* and air in the right retroperitoneum with no solid organ injury (figure 1).

DIFFERENTIAL DIAGNOSIS

Clinically, the following injuries were suspected:

CrossMark

To cite: Telfah MM. *BMJ Case Rep* Published Online First: [please include Day Month Year]. doi:10.1136/bcr-2016-215251

Figure 1 CT scan showing subhepatic fluid (black arrow) and retroperitoneal air (red arrow).

1. solid organ injuries of liver, spleen and pancreas (due to direct force of the trauma)
2. hollow viscus injury (due to sudden rise in intra-abdominal pressure)
3. mixed injuries.

TREATMENT

The patient was resuscitated according to advanced trauma life support (ATLS) principles. Urgent exploration of the abdomen was performed in the emergency department. The patient was operated by the general surgeon on call (MMT) as there was no paediatric surgeon in the same hospital and transfer to a tertiary centre at midnight in this situation was unsafe. Laparotomy through an upper midline incision revealed haemoperitoneum and bile stained fluid in the right upper quadrant. A systematic search showed no solid organ injury. Small and large bowels were examined and found to be normal. Right upper quadrant exploration revealed free blood and retroperitoneal haematoma around the head of the pancreas which masked the C-shaped part of the duodenum. Further mobilisation revealed transection of the duodenum at the junction of its first and second part (figure 2). The ampulla of Vater which was seen through the cut surface of the duodenum was intact and still secreting bile (figure 3). The lesser sac was explored and showed an intact pancreas. The defect in the duodenum was closed in two layers with washout of the peritoneal cavity and drainage using a corrugated drain next to the repair (figure 4). A jejunostomy tube was inserted intraoperatively and used for enteral feeding; a nasogastric tube was used for decompression of the stomach. The patient was managed in the intensive care unit for the first 48 hours and then transferred to the ward. After 72 hours, the child showed bowel movements and was clinically stable. Enteral feeding was started using the already fixed jejunostomy tube. The inflammatory markers white cell count and C reactive protein (WBC and CRP) were stable throughout the post-operative period and all other biochemical tests were within the normal range including amylase level.

Figure 2 Kocher mobilisation of the duodenum showing transection/rupture at the junction of D1 and D2.

OUTCOME AND FOLLOW-UP

The patient underwent an upper gastrointestinal (GI) contrast study on day 7 using water-soluble contrast which showed no leakage from the anastomosis and smooth passage of the contrast down to the small bowel (figure 5). The intra-abdominal drain was removed immediately after confirming the integrity of the repair. The patient remained well, showed no evidence of fistula and was discharged home on the 10th postoperative day. The patient had regular follow-up and a second contrast study performed 6 weeks later showed a smooth outline of the duodenum and no evidence of stenosis.

Figure 3 The ampulla of Vater shown on the floor of the transected duodenum (tip of the arrow).

Figure 4 Primary repair of the duodenum and drainage of the peritoneal cavity using a corrugated drain adjacent to the repair.

DISCUSSION

Injuries of the duodenum are uncommon due to its retroperitoneal location. Most duodenal injuries are caused by penetrating injuries and less frequently by blunt trauma.¹ The mechanism of duodenal injuries in paediatrics is different as most duodenal injuries are caused by blunt trauma.² The incidence of duodenal injuries following trauma varies from 3% to 5% and most of these injuries are associated with other visceral injuries because of the close anatomic relationship of the duodenum to other organs and major vessels.³ Isolated duodenal injury is rare in patients with abdominal trauma and, overall, it is found in only 0.6% of

patients who had duodenal injury following abdominal trauma.⁴ Our case report is of a child with this rare injury following blunt abdominal trauma.

Anatomically, the duodenum is a C-shaped hollow organ that lies in the upper abdomen (measuring 25 cm); it has four parts: superior, descending, horizontal and ascending (D1, D2, D3 and D4, respectively). It is bounded proximally by the pyloric sphincter and distally by the duodeno-jejunal flexure (DJ), which has an acute abrupt angle with the jejunum, and is fixed to the posterior abdominal wall via the ligament of Treitz (suspensory smooth muscle of the duodenum). Basically, the duodenum is retroperitoneal organ and has no mesentery; therefore, it has a fixed structure except for the anterior half of the first part which is intraperitoneal and mobile.⁵

There are different mechanisms involved in blunt duodenal injury.⁶ These include: crushing injuries, bursting (blow-out) injuries and shearing injuries which lead to disruption of the duodenal wall between the junctions of the fixed and mobile portions of the duodenum.⁶ In crushing injuries, when direct trauma is applied to the upper abdomen, the force will be transmitted through the duodenum against the lumbar vertebra which leads to crushing of the organ between the abdominal wall and vertebrae.⁶ In bursting (blow-out) injuries, a closed-loop effect is created when force is applied to the duodenum at the time of contracted proximal pylorus and distal suspensory ligament at DJ flexure. This effect results in duodenal rupture due to increased intraluminal pressure.⁶

In this case scenario, there is a mixed mechanism of crushing and blow-out injury following the fall of a heavy object on the upper abdomen of the child with direct force and a sudden rise in the intraluminal pressure in the duodenum (combined effect). The duodenal transection occurred between the first (D1) and the second (D2) part of the duodenum at the level of the ampulla of Vater, which defines the junction between the foregut and the midgut in embryonic life.⁵

Duodenal injuries are commonly associated with other injuries to the neighbouring structures in the upper abdomen (eg, pancreas, bile duct, major blood vessels). As the duodenum lies in the retroperitoneum, injuries may be hidden and discovered at a late stage or during laparotomy performed for other suspected injuries. A CT scan may show gas in the periduodenal region which may be the only sign suggesting duodenal injury.⁷

The morbidity and mortality following duodenal injury are high and strongly related to the timing of diagnosis and treatment. According to Lucas and Ledgerwood, a mortality rate of 11% was reported in patients with a duodenal injury who had an emergency operation, and this has increased up to 40% in those patients experiencing a delay in their diagnosis and management.⁸ Corley *et al* reported a mortality rate of 25% for duodenal injuries.⁹

In our clinical scenario, the presentation (within 6 hours) and operative treatment were early as the patient showed frank features of peritonitis secondary to blunt abdominal trauma with suspicious CT scan findings. We assume that the good outcome in this case scenario could be attributed to these two factors.

According to the American Association for the Surgery of Trauma, duodenal injuries were graded based on the extent of damage to the organ as five grades (I, II, III, IV and V).¹⁰ These grades are very helpful as a guide for the operative intervention required for duodenal injuries. However, other factors may play a role in determining the optimum operative treatment, for example, early versus late presentation, presence or absence of other organ injuries and the relation of the injury to the ampulla of Vater.⁸ Organ injury scale defines grade III injury as laceration

Figure 5 Upper gastrointestinal contrast study showing no leakage and smooth passage of contrast.

of the duodenum that caused disruption of 50%–75% of the circumference of the second part of the duodenum (D2) or disruption of 50%–100% of the circumference of the first, third or fourth part of duodenum (D1, D3, D4, respectively).¹⁰

The child in this case scenario has a grade III duodenal injury, involving 50%–75% of the circumference at the junction of D1 and D2. The ampulla is intact and it is a completely isolated duodenal injury with normal other viscera.

The operative management of duodenal injuries represents a dilemma to the surgeon as there are many surgical procedures of which no single method of duodenal repair can completely eliminate the dehiscence of the suture line. Minor injuries can be repaired primarily while major injuries and those also involving the head of the pancreas should undergo initial damage control surgery and be referred for definitive care. The on-call surgeon (whether general surgeon or paediatric surgeon) should have detailed knowledge of the available options of repair and, more importantly, their correct application in both adult and paediatric populations.¹¹

Historically, surgical treatment of duodenal injuries relied mainly on complex operations such as tube duodenostomy and diverticulisisation. Gradually, the recommendations for duodenal repair are changing. The current trend is towards primary closure with or without pyloric exclusion (PE) for most duodenal injuries, whereas complex injuries are managed by PE with gastro-jejunostomy or by using pancreatico-duodenectomy.¹²

The majority of traumatic duodenal perforations can be managed safely with simple surgical procedures, for example, PR using one or two layers especially for penetrating injuries. On the other hand, a minority of cases represent high-risk injuries which increase the likelihood of dehiscence following simple repair. These injuries require an additional procedure to decrease the incidence of dehiscence of the duodenal suture line.¹¹ These injuries include duodenal injury associated with biliary or pancreatic injuries, high-velocity missile or blunt injury, damage to more than 75% of the circumference, injury to D1 or D2, the time interval between injury and repair of more than 24 hours.¹³ In our case, there were elements suggestive of high-risk injury such as blunt trauma and involvement of D2; however, the presence of isolated injury, laceration of less than 75% of the wall and early presentation were factors that favoured PR alone.

Surgical repair of the duodenum can be accomplished using one or two layers. If the defect is large and PR may affect the lumen of the duodenum, then a pedicled mucosal flap using jejunum or stomach may be used. Another option is to use a jejunal serosal patch to close the defect. In complete transection of the duodenum, primary anastomosis of the two ends can be accomplished in D1, D3 and D4. In D2 injury, due to the shared blood supply with the head of the pancreas, it is difficult to mobilise and primary anastomosis to Roux-en-Y loop over a duodenal defect is the treatment of choice.¹¹

Duodenal diversion is indicated in high-risk duodenal injuries to protect duodenal anastomosis by diverting the proteolytic enzymes of the GI tract. The diversion was originally made using three decompression tubes (gastrostomy tube, retrograde jejunostomy tube and antegrade jejunostomy tube).¹¹ Duodenal diverticulisisation is also another option, but all these techniques are extensive procedures. An alternative to these procedures to decrease the operative time was devised using PE.¹⁴

Most of the literature about the management of duodenal injuries deal with adult populations and to a lesser extent combines paediatric and adult populations. Only a few published studies specifically deal with the natural history, mechanism and treatment options for duodenal injuries in children.

Clendenon *et al*¹⁵ reported in their retrospective review that duodenal injuries in children (42 children) are mainly blunt in nature and had a very low mortality rate. When surgical intervention is required, PR is usually feasible. They also found that PR of the duodenum is a viable operative choice for the treatment of mild to moderately severe duodenal injuries. Equally important, the routine diversion of all duodenal injuries was unnecessary.

According to Shilyansky *et al*,¹⁶ primary duodenorrhaphy can be used to repair a tear in duodenum with healthy looking tissues from the adjacent duodenal wall and no other GI tract injuries; however, additional intervention was required in cases that are associated with GI tract injuries or when the surrounding tissues looked unhealthy.

Girgin *et al*¹⁷ reported their results in a comparative study of PR alone versus repair plus diversion using tube duodenostomy in 67 patients who had duodenal injuries. They concluded that PR was appropriate in the majority of duodenal injuries; on the other hand, the combination of tube duodenostomy with the PR of the defect increased hospital stay and did not improve the clinical outcome.

Siboniet *al*¹⁸ queried the National Trauma Data Bank for all blunt trauma patients with duodenal injuries and then identified cases of isolated blunt trauma. They studied this category of duodenal injury and compared the outcome following PR alone versus repair with gastro-enterostomy. They found that patients undergoing PR had a similar mortality rate to those undergoing diversion using gastro-enterostomy; however, hospital stay was shorter for those who underwent PR. The authors illustrated that even in cases of severe duodenal injuries, primary closure is associated with a shorter hospital stay without affecting mortality when compared with closure and diversion using gastro-enterostomy.

In another study performed by Smiley *et al*¹⁹ in a paediatric trauma centre in Lexington, the authors found that PR alone performed for isolated complex duodenal injuries was feasible and safe. They reviewed the database between 2003 and 2011 and identified seven cases of isolated injuries of different grades including complete transection. All injuries were repaired primarily with the placement of drain and postoperative check for leakage using contrast studies. No complication was encountered in all patients.

The performance of PE during repair of complex injuries to prevent duodenal fistulas was studied by Seamon *et al*²⁰ in 29 patients managed with and without PE. There was a trend towards greater complication rates of duodenal fistula and increased hospital stay in patients treated with PE. Moreover, the effectiveness of the PE procedure is debatable in most of the literature. Cruvinel Neto *et al*²¹ conducted a review of the literature for cases of the PE procedure used to protect suture repair in complex duodenal injuries (injuries more than grade II). In all of the included retrospective studies, PE showed no improvement in the outcome; however, there is no sufficient high-quality evidence to abandon this procedure.

The external drainage of the abdominal cavity following duodenal injuries is important as it will allow early detection and control of duodenal fistulas.^{11 19} This can be accomplished using a simple drain adjacent to the repair. Equally important is the use of feeding jejunostomy to enhance nutrition post-operatively which is highly recommended following duodenal injuries.¹¹ Decompression of the upper GI tract is important to decrease a load of gastric juice on duodenal anastomosis. This has been accomplished in our case using a nasogastric tube with intermittent suction to maintain drainage. Also, we drained the

peritoneal cavity using a corrugated drain next to the repair and used a feeding jejunostomy tube for postoperative feeding.

In conclusion, the choice of PR alone or repair combined with diversion for duodenal injuries is a clinical decision and largely depends on the nature of the injury. From our review of the literature, we feel that our patient has been given the best operative management based on the best available evidence without jeopardising the safety of the patient. For such injuries, PR of the duodenum without diversion was a safe treatment.

Patient's perspective

"We were completely shocked when we saw our kid under the huge TV box. We could not imagine anything apart from death after such an accident. We jumped into our car and brought him to the emergency department. After resuscitation we were not surprised with the decision to have emergency procedure. We knew later about the type of the injury which is rare and we were given the worst case scenario. Finally after ten days we went back home with our child and we are thankful to all healthcare workers involved in the management."

Learning points

- ▶ Duodenal injuries are usually associated with other visceral injuries following blunt abdominal trauma, but isolated duodenal rupture is rare.
- ▶ Duodenal rupture following a sudden increase in intra-abdominal pressure usually occurs at the junction of the first (intraperitoneal and mobile) and the second part (retroperitoneal and fixed) of the duodenum.
- ▶ Primary repair alone is as effective as repair with diversion or even better only if performed in the presence of favourable factors according to several studies (evidence-based approach).
- ▶ The isolated injury, the grade of the injury, the possibility of minimal contamination and haemodynamic stability of the patient were the factors favouring primary repair of the duodenum alone without diversion in this case scenario. Moreover, the good outcome was attributed to the early presentation together with early management.

Acknowledgements The author would like to thank all the nursing staff in Unit Number 1, Aljumboori Teaching Hospital, and the theater staff of the emergency department for their efforts and hard work; Dr Ali Aziz, the on-call anaesthetist; and Dr Thamer Mosleh and Dr Ali Jasim, the surgical registrars, for their hard work and timely response. Their efforts and commitment are highly appreciated.

Contributors Muwaffaq M. Telfah (MMT) was the general surgeon on call who received the patient in the emergency department and supervised his resuscitation. MMT was also the operating surgeon as the Hospital did not have a paediatric

surgeon on call and the patient was not stable enough for transfer to a paediatric surgery hospital. MMT was responsible for postoperative care and follow-up of the patient and finally he wrote up this article to document the case and to provide educational message from this case to the literature.

Competing interests None declared.

Patient consent Consent obtained from next of kin.

Provenance and peer review Not commissioned; externally peer reviewed.

© BMJ Publishing Group Ltd (unless otherwise stated in the text of the article) 2017. All rights reserved. No commercial use is permitted unless otherwise expressly granted.

REFERENCES

- 1 Boone DC, Peitzman AB, et al. Abdominal Injury - duodenum and pancreas. In: Peitzman AB, Rhodes M, Schwab SW, eds. *The Trauma Manual*. Philadelphia, Pennsylvania: Lippincott-Raven, 1998:242–7.
- 2 Clendenon JN, Meyers RL, Nance ML, et al. Management of duodenal injuries in children. *J Pediatr Surg* 2004;39:964–8.
- 3 Costa JA, et al. Management of specific injuries, injuries to the duodenum. In: Townsend CM, Beauchamp RD, Evers BM, eds. *Sabiston textbook of surgery*. 18th edn. Philadelphia: Saunders-Elsevier, 2008:505–6. pp.
- 4 Siboni S, Benjamin E, Haltmeier T, et al. Isolated blunt duodenal trauma: simple repair, low mortality. *Am Surg* 2015;81:961–4.
- 5 Gray H, Lewis WH. *Gray's Anatomy of the Human Body*. 20th edn. New York, NY: Bartleby, 2000.
- 6 Asensio JA, Feliciano DV, Britt LD, et al. Management of duodenal injuries. *Curr Probl Surg* 1993;30:1026–92.
- 7 William NS, Bulstrode CJK, O'Connell PR. *Bailey & Love's Short Practice of Surgery*. 26th edn. London: CRC Press, 2013.
- 8 Lucas CE, Ledgerwood AM. Factors influencing outcome after blunt duodenal injury. *J Trauma* 1975;15:839–46.
- 9 Corley RD, Norcross WI, Shoemaker WC. Traumatic injuries to the duodenum: a report of 98 patients. *Ann Surg* 1975;181:92–8.
- 10 Moore EE, Cogbill TH, Malangoni MA, et al. Organ injury scaling, II: pancreas, duodenum, small bowel, colon, and rectum. *J Trauma* 1990;30:1427–9.
- 11 Degiannis E, Boffard K. Duodenal injuries. *Br J Surg* 2000;87:1473–9.
- 12 Velmahos GC, Kamel E, Chan LS, et al. Complex repair for the management of duodenal injuries. *Am Surg* 1999;65:972–5.
- 13 Boone DC, Peitzman AB, et al. Abdominal Injury- Duodenum and pancreas. In: Peitzman AB, Rhodes M, Schwab SW, eds. *The trauma manual*. Philadelphia, Pennsylvania: Lippincott-Raven, 1998:242–7.
- 14 Ivatury RR, Nassoura ZE, Simon RJ, et al. Complex duodenal injuries. *Surg Clin North Am* 1996;76:797–812.
- 15 Clendenon JN, Meyers RL, Nance ML, et al. Management of duodenal injuries in children. *J Pediatr Surg* 2004;39:964–8.
- 16 Shilyansky J, Pearl RH, Kreller M, et al. Diagnosis and management of duodenal injuries in children. *J Pediatr Surg* 1997;32:880–6.
- 17 Girgin S, Gedik E, Yağmur Y, et al. Management of duodenal injury: our experience and the value of tube duodenostomy. *Ulus Travma Acil Cerrahi Derg* 2009;15:467–72.
- 18 Siboni S, Benjamin E, Haltmeier T, et al. Isolated Blunt Duodenal Trauma: simple repair, low mortality. *Am Surg* 2015;81:961–4.
- 19 Smiley K, Wright T, Skinner S, et al. Primary closure without Diversion in Management of Operative Blunt Duodenal Trauma in Children. *ISRN Pediatr* 2012;2012:1–4.
- 20 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.
- 21 Cruvinel Neto J, Pereira BM, Ribeiro MA, et al. Is there a role for pyloric exclusion after severe duodenal trauma? *Rev Col Bras Cir* 2014;41:228–31.

Copyright 2017 BMJ Publishing Group. All rights reserved. For permission to reuse any of this content visit <http://group.bmj.com/group/rights-licensing/permissions>.
BMJ Case Report Fellows may re-use this article for personal use and teaching without any further permission.

Become a Fellow of BMJ Case Reports today and you can:

- ▶ Submit as many cases as you like
- ▶ Enjoy fast sympathetic peer review and rapid publication of accepted articles
- ▶ Access all the published articles
- ▶ Re-use any of the published material for personal use and teaching without further permission

For information on Institutional Fellowships contact consortiasales@bmjgroup.com

Visit casereports.bmj.com for more articles like this and to become a Fellow