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Identifying blunt duodenal injury by bicycle handlebar with methylene blue

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CASE REPORT

A patient in their 30s with a past medical and surgical history significant for asthma and left laparoscopic ovarian cystectomy presented to the emergency room after falling off their bike 12 hours prior. They were riding a bicycle and attempted to avoid hitting a car, however, they swerved on their bike, resulting in them flipping over their handlebars and the handlebars hitting their epigastrium. They did not suffer a head injury or have a loss of consciousness. However, they did admit to drinking alcohol before the accident. Subsequently, after the accident, they went to sleep. On waking, they had severe abdominal pain, nausea, chills, and multiple episodes of non-bloody, nonbilious emesis. They did not pass flatus or have bowel movements. Due to the unrelenting pain, the patient came to the emergency department.

Vital signs were the following: temperature: 37.2°C, heart rate 70/min, blood pressure 150/94 mm Hg, respiratory rate 17 on room air. The abdominal examination was notable for abrasion to the mid-abdomen, distension, voluntary guarding, and rigidity, concerning for an acute abdomen. Labs were remarkable for a leukocytosis of 13.4. All other labs were within normal limits, including liver function tests and lipase. CT was obtained which showed, '*Complex free fluid collection throughout the abdomen and pelvis. Free air and stool material which appears to be extraluminal in nature surrounding the third and fourth portions of the duodenum. Bowel injury is suspected* (figure 1).'

WHAT WOULD YOU DO?

A. Diagnostic laparoscopy
B. Exploratory laparotomy with the performance of Kocher maneuver
C. Exploratory laparotomy with the performance of extended Kocher maneuver
D. Exploratory laparotomy with methylene blue for visualization of the injury.

WHAT WE DID AND WHY

Correct answer: D

When the patient arrived in the operating room, an awake nasogastric (NGT) was placed. After general anesthesia was induced, the peritoneal cavity was accessed through a midline incision and initial inspection revealed minimal brown, free fluid, but no obvious succus or stool. The ligament of Treitz (LOT) was identified and inspection of the entire small bowel and colon revealed no injuries. The extended Kocher maneuver was used to fully mobilize the ascending colon and identify the first through proximal third portion of the duodenum, which revealed no injuries. We identified the LOT again and dissected the LOT and the fourth portion of the duodenum up to the superior mesenteric artery (SMA) and still did not find any injuries. Of note, an area of inflammation in the retroperitoneum was noted at the level of aortic bifurcation and iliac vessels.

Since the injury was still unable to be visualized, methylene blue was given through the NGT, which pooled at the previously identified area of inflammation (figure 2). A decision was made to open that area to access the retroperitoneum. On opening of the retroperitoneum, bile, succus, and methylene blue poured out. We followed the track of the retroperitoneum to a more proximal part of the duodenum, next to the SMA. This guided us to dissect the posterior aspect of the third portion of the duodenum, which revealed a duodenal perforation that was less than 50% circumference of the bowel and a preserved inferior mesenteric vein (figure 3). The duodenal repair was performed in two layers using 3–0 Vicryl in running fashion and Lembert sutures interrupted with 3–0 silks. The repair was buttressed with omentum and tacked down with 3–0 Vicryl over the area of injury. The postoperative course was uncomplicated—an upper gastrointestinal (GI) study was performed on postoperative day 1 which showed no evidence of leak, and the patient was subsequently discharged on postoperative day 5 after the patient had a return of bowel function and was tolerating diet.

DISCUSSION

Duodenal injury is rare, constituting 3% to 5% of abdominal injuries[1] and is often secondary to high-energy trauma. Additionally, this injury has higher rates of mortality and complications, as the retroperitoneal positioning of the duodenum lends itself to a delayed diagnosis.[2] Duodenal injuries also rarely occur in isolation and are usually associated with injury to other organs such as the liver, colon, pancreas, other parts of the small bowel, and stomach.[3] Moreover, only 22.3% of duodenal injuries are from blunt mechanisms, with the majority of duodenal trauma being caused by penetrating mechanisms.[4]

The mechanism of blunt injuries is due to either a crush injury or compression injury, with the most frequent cause being motor vehicle accidents with the impact of the steering wheel on the epigastrium.[3] The most injured part of the duodenum is the second, followed by the third, fourth, and first.[5] Moreover, a vast majority of duodenal injuries

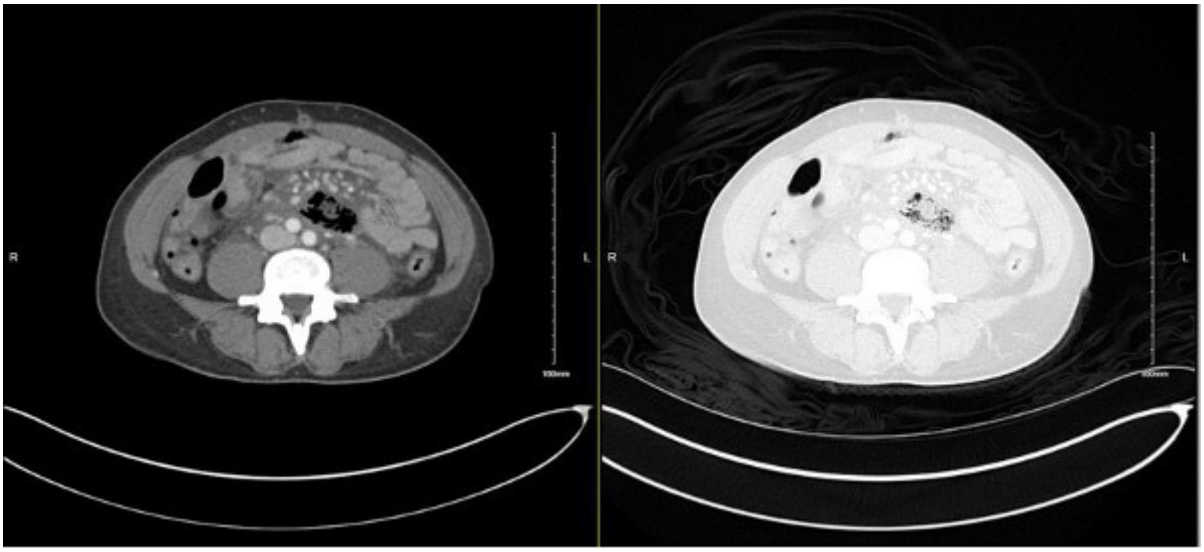

Figure 1 Computed tomography abdomen pelvis (CTAP) axial view of abdomen with intraperitoneal free air in relation to perforation of third duodenal portion.

occur in conjunction with other organs due to their proximity to other structures.

Due to the retroperitoneal location of the duodenum, initial signs and symptoms may be missed, with rigidity and guarding occurring later once there is extravasation into the peritoneal cavity as in this patient. Prompt intervention is of paramount importance as surgery performed within the initial 24 hours decreases rates of morbidity from 60% to 30% and mortality from 25% to 6%.[6] Early surgery also reduces complications including duodenal fistula, abdominal abscess, intestinal obstruction, and acute pancreatitis.

The primary intervention for duodenal injuries is surgical repair and debridement. Principal factors in navigating surgical repair include: the location of the lesion, the depth of the

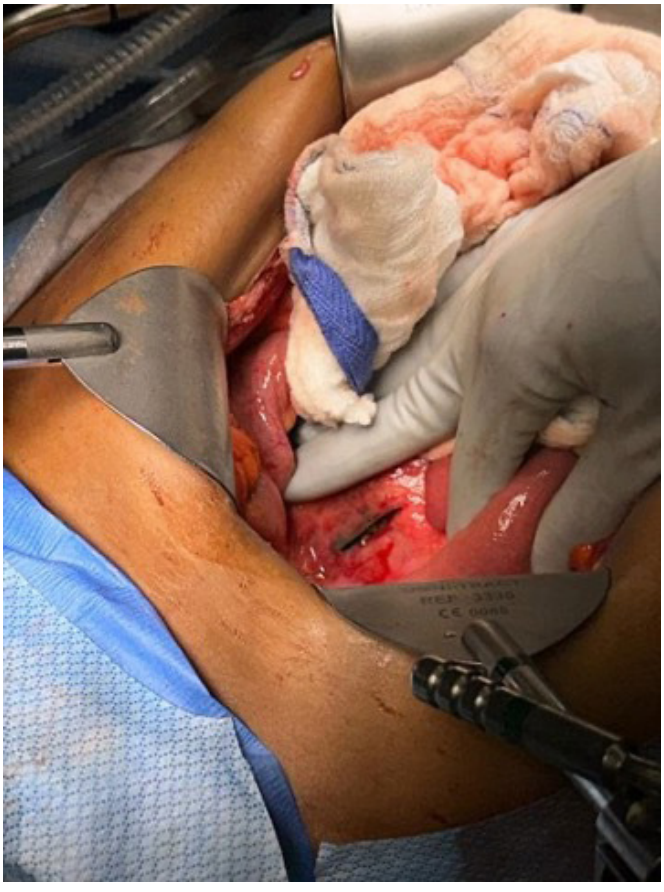

Figure 2 Methylene blue pooling in the retroperitoneum at the level of the aortic bifurcation and iliac vessels.

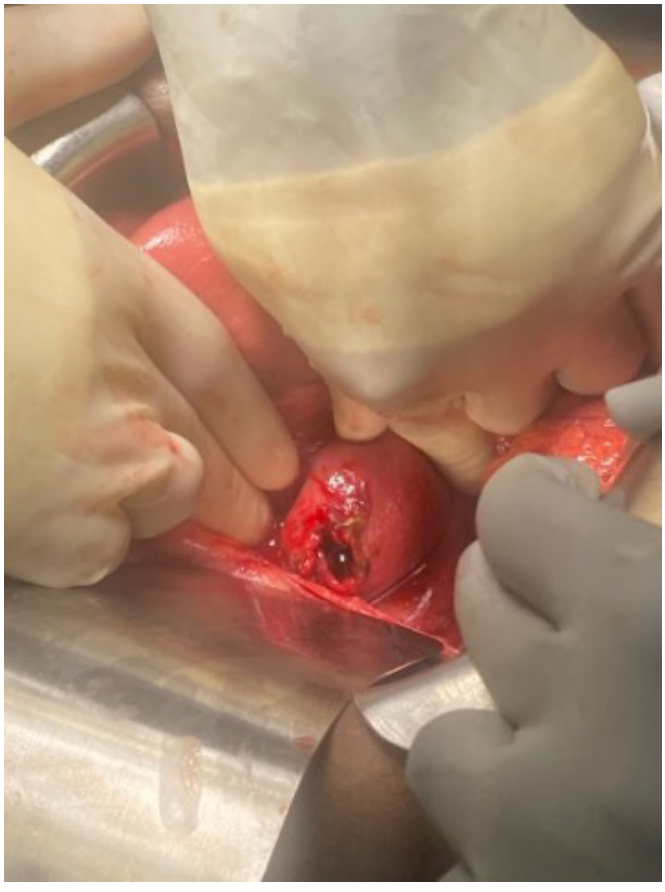

Figure 3 Perforation in the distal posterior third portion of the duodenum less than 50% of the circumference of the bowel.

lesion, and injury to nearby structures.[7] Both Kocher and Cattell-Braasch maneuvers are used to gain exposure and facilitate surgical access to the duodenum. Kocher's maneuver is primarily performed to mobilize and expose D1 and D2 whereas the Cattell-Braasch maneuver is especially useful in providing access to the third and fourth portions of the duodenum.[8] In our patient, these maneuvers were not enough to gain access to the site of injury, so methylene blue was used to localize the injury to the posterior part of the third portion of the duodenum. Methylene blue proved to be a simple and quick solution to identify the injury. Table endoscopy is another option for visualization of injuries to the duodenum. Still, it is technically challenging to visualize the third portion of the duodenum with table endoscopy, especially in the setting of the patient being in a prone position with an open abdomen. In our patient, the endoscopy would lead us to an incomplete answer of where the perforation was located. However, it is possible with specialized techniques and instruments, such as a longer or more flexible scope, known as a push enteroscope or a double-balloon enteroscope.[9] These advanced scopes allow for deeper examination into the small intestine beyond the second portion of the duodenum.

Primary repair alone (PRA) and complex repairs with adjunctive measures (CRAM) are two approaches to managing traumatic duodenal injuries. PRA involves simple suturing of the injury, and it is generally favored for less severe injuries. In contrast, CRAM involves more extensive procedures such as pyloric exclusion, gastrojejunostomy, triple tube drainage, or even partial duodenectomy, which are used for more severe injuries or when primary repair is insufficient. CRAM does not confer additional protective benefits against duodenal leaks or improve outcomes when leaks occur; therefore, PRA is recommended for all grades of duodenal injury whenever feasible, as it appears to reduce the incidence of leaks and is associated with fewer complications.[10] Due to the feasibility of repair and the injury being <50% of the circumference of the bowel, PRA was used to repair the duodenal injury in this patient.

Methylene blue is recognized for its versatile applications, serving as a histological dye, an antidote for methemoglobinemia,[11] and a tracer for sentinel lymph node biopsy, among other purposes.[12] Beyond these well-established uses, it has been employed in combination with angiography to pinpoint obscure gastrointestinal bleeding.[13–17] Notably, there is a documented patient in literature where methylene blue successfully localized a bleeding jejunal diverticulum,[18] proving it to be an effective technique. There is another instance in literature where methylene blue was employed as a marker to detect mucosal perforations during laparoscopic pyloromyotomy in pig models with perforations of 1.2 mm and greater.[19] However, our patient represents the first documented utilization of methylene blue for the localization of duodenal perforations in humans.

The use of methylene blue to identify abdominal trauma is a novel and promising technique offering the surgeon a valuable tool in the management of gastrointestinal complications. The use of methylene blue offers several benefits in the localization of bowel perforations. First, it provides real-time feedback to the surgeon, aiding in the precise identification of the perforation site. This can be particularly advantageous in patients where the perforation is small or located in challenging anatomic regions. Second, the method is relatively simple, cost-effective, and minimally invasive compared with alternative approaches, reducing patient morbidity and healthcare costs. Additionally, methylene blue is safe for clinical use, with minimal adverse effects reported. The dye is well tolerated and has a low risk of allergic reactions. Overall, methylene blue represents a novel and effective approach to localizing bowel perforations, offering clinicians a valuable tool in the diagnostic arsenal.

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