

## Early Imaging Identification of Traumatic Mesenteric and Bowel Injury: An illustrative case of bucket-handle mesenteric avulsion injury with delayed presentation as small bowel obstruction

Ashton Densley<sup>1,\*</sup>; Ansar Wali<sup>2</sup>; Steve Mathew<sup>1</sup>; Christian W Cox<sup>1</sup>

<sup>1</sup>Department of Radiology, Creighton University Medical Center, Omaha, Nebraska.

<sup>2</sup>Creighton University School of Medicine. Omaha, Nebraska.

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**\*Corresponding Author:** Ashton Densley, Department of Radiology, Creighton University Medical Center 7710 Mercy Road, suite 502 Omaha, NE 68124, USA.  
Email: [ashtondensley@creighton.edu](mailto:ashtondensley@creighton.edu)

### Abstract

Traumatic small bowel and mesenteric injuries (SBMI) are uncommon sequelae of blunt trauma. Imaging findings in SBMI can be subtle with varying degrees of sensitivity and specificity, requiring a high level of suspicion given the high associated morbidity and mortality. Imaging findings include seat-belt distribution subcutaneous edema, flexion-distraction fractures, free fluid without a source, asymmetric bowel wall thickening, interloop edema, bowel ischemia, pneumoperitoneum, and even delayed bowel obstruction. A specific subtype of SBMI is an avulsion injury of the small bowel mesentery, which is described as a “bucket handle” defect within surgical literature. This case report highlights the temporal evolution of imaging findings present in cases of traumatic SBMI and is illustrative of how those clinical and imaging findings can inform management decisions.

### Introduction

The Eastern Association of Surgery of Trauma trial of 275,555 patients demonstrated SBMI frequency of 1% in overall blunt trauma admissions, and within 3% of patients worked up for blunt abdominal trauma, with significant associated mortality of 19% and morbidity of 28.9% [1]. The underlying mechanism for SBMI is the result of either rapid deceleration, compression or crush injuries [2]. These mechanisms can create a mesenteric avulsion that occurs when a segment of the bowel, typically separates itself from the mesentery, leaving a devascularized segment that looks like a handle on a bucket [3]. Concurrent direct bowel injuries may occur due to the aforementioned mechanisms, or as a delayed consequence about 48-72 hours post initial injury due to devascularization leading to tissue ischemia/necrosis [4,5]. Small bowel and mesentery injury in a polytrauma patient is associated with poor morbidity and mortality because clinical diagnosis can be challenging and manifestations may be delayed resulting in severe complications, which mainly relate to bleeding, peritonitis, and sepsis [6]. Imaging has become the gold standard to evaluate blunt abdominal trauma, although imaging diagnosis of SBMI can also be challenging [7]. In fact, SBMI were the most commonly missed injuries by experienced radiologists on CT scans in the trauma setting [8]. The prototypical patient affected by

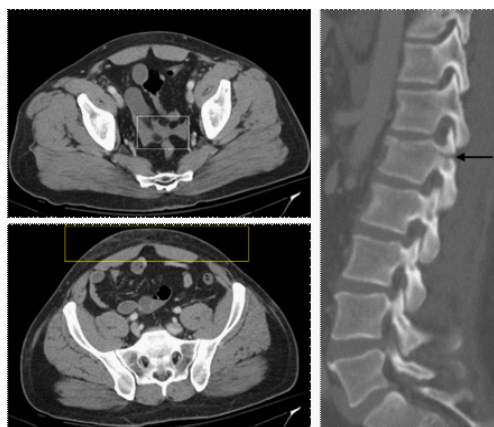
SBMI is a restrained driver/passenger status post motor vehicle accident with distal/terminal ileal injury [4]. The following case report expands on the pre-existing literature of SBMI, illustrating clinical and imaging signs of SBMI, other concomitant injuries, and the non-operative course of the injury, with subsequent surgical determination of bucket-handle injury of the small bowel mesentery.

### Case Report

A 35-year-old restrained male driver in a high-speed rapid-deceleration motor vehicle collision presented to an outside hospital with transient loss of consciousness, abdominal pain, and pain in multiple extremities. The vehicle was traveling at 70 mph prior to a rear-end collision with a semi truck. Initial radiographs performed at the referring community hospital demonstrated fractures of the left clavicle, radius, and ulna as well as an open right femoral shaft fracture. The primary and secondary survey revealed abdominal tenderness, left upper extremity tenderness, as well as right lower extremity tenderness and deformity. Ecchymosis extended diagonally from the left shoulder across the chest and abdomen to the right lower quadrant. Ecchymosis also extended horizontally along the lower abdominal wall. This pattern of ecchymosis constitutes a positive seatbelt sign.

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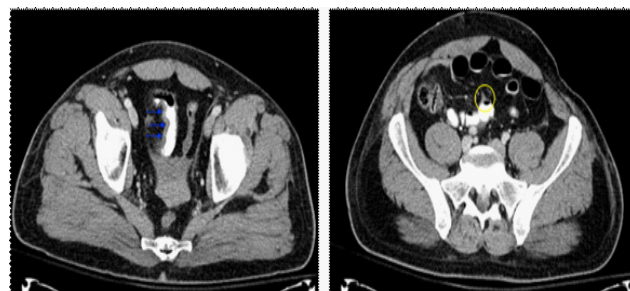
Upon presentation to our Level I Trauma Center, bedside FAST exam demonstrated no free intraperitoneal fluid. Initial CT abdomen and pelvis with IV contrast in portal venous phase demonstrated high-attenuation fluid in the intraperitoneal pelvis (**Figure 1a**). Extraperitoneal injuries included a non-displaced Chance fracture of the L1 vertebral body (**Figure 1b**), and anterior abdominal superficial soft tissue edema in a pattern compatible with seatbelt injury (**Figure 1c**). Given the non-simple attenuating intraperitoneal fluid, the trauma team was alerted about the possibility of bowel injury. The decision was made to continue non-operative management. A 24-hour follow-up CT of the abdomen and pelvis with oral and IV contrast revealed asymmetric bowel wall thickening of a loop of distal ileum (**Figure 2a**) with adjacent loops demonstrating interloop edema assuming a polygonal shape (**Figure 2b**). Given the progression of findings, concern for SBMI was again raised on imaging interpretation. Over the next several days, the patient developed fevers, tachycardia, altered mental status and progressive abdominal pain and distention. The patient's hemoglobin progressively dropped from 10.9 to 6.8. Anemia persisted with a hemoglobin value of 6.7 following red blood cell transfusion. Repeat CT of the abdomen and pelvis with IV contrast on hospital day six then demonstrated interval development of small bowel obstruction with transition point at the distal ileum, just distal to a non-enhancing loop of bowel, likely due to ischemia secondary to mesenteric injury (**Figures 3 and 4**).



**Figure 1:** a) IV-contrast enhanced axial pelvis CT demonstrating non-simple attenuation fluid in the pelvis (white square). There is no identifiable solid organ injury (not illustrated above). In the setting of trauma, findings are consistent with hemoperitoneum of unknown origin.

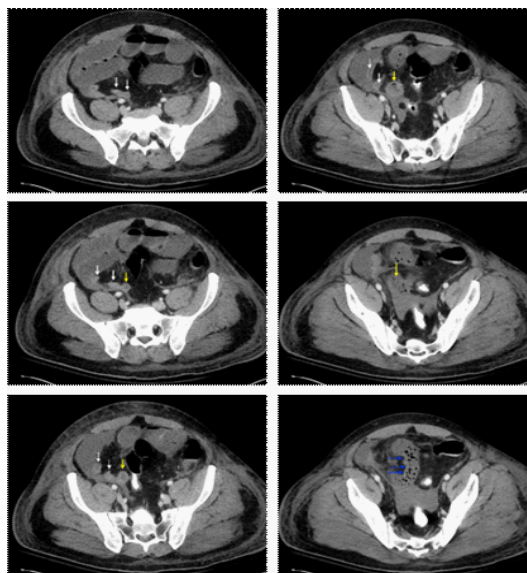
b) IV-contrast enhanced axial pelvis CT demonstrating horizontally-oriented fat stranding (yellow square) in the superficial subcutaneous tissue of the lower abdominal wall. The imaging findings correlate with provided clinical history of ecchymosis in the distribution of a seatbelt (i.e. seatbelt sign).

c) IV-contrast enhanced axial pelvis CT (bone window) demonstrating acute L1 anterior wedge vertebral body fracture with a horizontal fracture line through the posterior elements (black arrow). Three-column injuries with this configuration, otherwise known as a chance fracture or seatbelt fracture, indicate a flexion-distraction type injury mechanism.

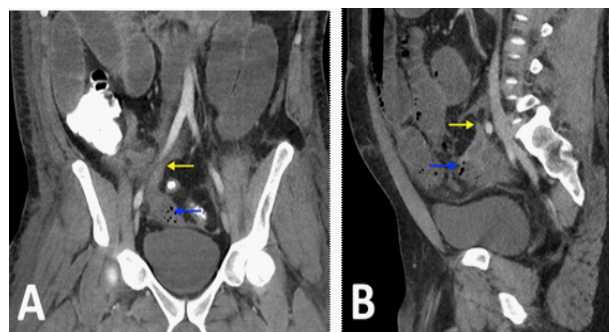


**Figure 2:** a) IV and oral-contrast enhanced axial pelvis CT demonstrating short interval (1 day) development of asymmetric bowel wall thickening (blue arrows) in a loop of opacified distal ileum.

b) IV and oral-contrast enhanced axial pelvis CT demonstrating interloop edema with triangular configuration (yellow circle) adjacent to a segment of distal ileum. In the setting of trauma, this is suggestive of mesenteric injury, and a potential source of hemoperitoneum in this trauma patient without solid organ injury.



**Figure 3:** a-f) Sequential slices from IV contrast-enhanced axial pelvis CT demonstrating multiple fluid-filled loops of dilated small bowel with caliber tapering (yellow arrows) to distally decompressed distal ileum (white arrows), representing short interval (5 days) development of small bowel obstruction. Just proximal to the transition point is a segment of hypoenhancing ileum (blue arrows) containing fecalized stool contents. This corresponds to the region of asymmetric bowel wall thickening and interloop edema identified on the preceding CT (see Figure 2), raising the degree of suspicion for mesenteric injury with resultant focal bowel ischemia and causative obstruction.



**Figure 4:** a-b) Coronal and sagittal IV contrast-enhanced pelvis CT demonstrating the small bowel obstruction focal caliber transition point (yellow arrow) adjoining the segment of hypoenhancing bowel (blue arrows).

The trauma team was informed about the findings and the patient was taken emergently for an exploratory laparotomy, which revealed ischemic distal small bowel, devascularized by a bucket handle tear of the mesentery. Resection of the ischemic bowel was followed by re-anastomosis of healthy bowel segments. The patient had a subsequent uneventful postoperative course and recovery.

## Discussion

In the setting of nonspecific physical exam and imaging findings in SBMI, a combination of these signs are typically needed to raise clinical concern for the diagnosis [9]. Attempts should be made to differentiate SBMI amenable to surgical intervention from those that can be medically managed. [10]. The four layers of the bowel wall include (deep to superficial): mucosa, submucosa, muscularis, and serosa. A significant bowel injury is defined as a tear through all four layers or a tear that extends past the serosa without involvement of the mucosa, requiring surgical intervention, while less severe cases such as bowel wall hematoma or a tear that only involves the serosa, may be considered for medical management [10]. Bowel injuries typically involve mesenteric injuries, although the converse is not always true [9]. Significant mesenteric injuries include active extravasation of contrast from the mesenteric vessels, mesenteric disruption and mesenteric injury leading to bowel ischemia [10].

Sensitive but nonspecific imaging signs of bowel injury include free intraperitoneal fluid, abnormal bowel wall enhancement, and bowel wall thickening [9]. Nonspecific but sensitive imaging signs of mesenteric injury include mesenteric stranding, or signs of bowel injury [10]. Bowel injuries can happen concurrently or be delayed and be secondary to devascularization and resultant ischemia. Specificity of the free intraperitoneal fluid can be further increased via use of a fluid attenuation coefficient. In a cohort of 669 consecutive blunt trauma male patients, intraperitoneal fluid with a mean attenuation (MA) of 45.1 Hounsfield units with standard deviation (SD) of 16.8 indicated a definable source (eg. bowel injury, mesenteric hematoma, solid organ injury), while a small volume free fluid with MA less than 22.5 indicated clinically insignificant incidental free fluid [11]. The abdominal seatbelt sign, particularly above or at the level of the anterior superior iliac spine, is an important predictor of SBMI [12].

Specific signs of bowel injury include visualization of extraluminal air, bowel tear, and extraluminal contrast in a CT with IV and oral contrast [9]. High specificity findings in mesenteric trauma include active extravasation of contrast into the peritoneum, mesenteric hematoma, or termination/irregularity of mesenteric vasculature [9]. In the case described, increased attenuation of the free intraperitoneal fluid, in addition to the presence of seatbelt sign in the setting of L1 Chance fracture, were strong indicators of a significant SBMI. The suggestion

of polygonal high attenuation interloop edema in the 24 hour follow-up along with asymmetric bowel wall thickening further supported the presence of a significant mesenteric injury. Moreover, the followup CT on hospital day 6 findings of bowel obstruction just distal to the region of ileum that had been previously thickened as well as reduced bowel wall attenuation of the thickened segment of ileum further increased the level of suspicion. It was confirmed surgically, that these represented evolving findings of bucket-handle mesenteric injury leading to bowel ischemia.

## Conclusion

Although uncommon, traumatic SBMI is associated with significant morbidity and mortality. Prospective diagnosis of bowel or mesenteric injury is a challenge as the clinical presentation and imaging findings are often subtle and nonspecific with delayed manifestation. As definitive diagnosis is often not possible without surgery, the role of radiology is to determine the level of suspicion. Understanding the associated injury mechanisms, and the relative specificity of each imaging finding is needed to maximize imaging diagnostic accuracy. This can prompt early operative intervention when indicated and avoid invasive measures when unnecessary, improving patient care and reducing morbidity and mortality. Through serial imaging, the presented case of bucket handle mesenteric injury illustrates the initial and evolving imaging findings of SBMI. While nonspecific, the initial CT seatbelt sign and high attenuation free fluid in the setting of significant blunt trauma were sensitive indicators of SBMI. However, the severity of bowel injury at initial presentation remained in question. The evolving clinical presentation with subsequent CT imaging signs of bowel wall thickening followed by bowel obstruction and segmental decreased wall enhancement led to surgical diagnosis and treatment of bucket handle mesenteric injury. While the findings were individually nonspecific and separated temporally, they were spatially localized to the same segment of bowel, prompting surgical intervention to confirm and treat the unifying diagnosis of SBMI.

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## Conflict of Interest:

The authors declare no conflicts of interest.

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