CT Findings of Mesenteric Injury After Blunt Trauma: Implications for Surgical Intervention

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OBJECTIVE. The purposes of this study were to determine the spectrum of CT findings of mesenteric injury, to compare CT findings of mesenteric injury with surgical observations, and to assess the potential of CT to predict which patients with mesenteric injury require laparotomy.

MATERIALS AND METHODS. Blunt trauma patients admitted to our facility during a 5-year 4-month period with a CT or surgical diagnosis of mesenteric injury were identified from a radiology database and trauma registry. Patients with CT findings of full-thickness bowel injury associated with mesenteric injury or diagnostic peritoneal lavage performed before CT were excluded. CT scans of all patients were retrospectively reviewed both with and without knowledge of surgical results. Medical records of all study patients were reviewed to ascertain admission physical findings and surgical results.

RESULTS. Twenty-seven of 29 patients meeting the study criteria underwent laparotomy, and two others were managed conservatively. Among the 27 patients who had surgery, 24 (89%) had CT findings of mesenteric injury confirmed. Surgical findings showed CT scans to be falsely negative in two other patients and falsely positive in one other patient. No major discrepancies were found between retrospective CT review done with and without knowledge of the surgical findings. Two CT findings unique to patients whose injuries, in the judgment of the surgical team, required surgical repair were active extravasation of IV contrast material and bowel wall thickening associated with mesenteric findings. Physical findings did not correlate well with the type and clinical significance of the mesenteric injury.

CONCLUSION. The CT finding of mesenteric bleeding or bowel wall thickening associated with mesenteric hematoma or infiltration in the blunt trauma patient indicates a high likelihood of a mesenteric or bowel injury requiring surgery. The finding of focal mesenteric hematoma or infiltration without adjacent bowel wall thickening is nonspecific and can occur both in mesenteric or bowel lesions that require surgery and those that do not.

Injury to the mesentery, although relatively uncommon, represents a significant source of morbidity and mortality from blunt abdominal trauma [1]. Early detection and surgical intervention, when required, are critical to improve outcome [1]. Previous studies indicate that abdominal CT with oral contrast material is useful to detect injury to the bowel and mesentery [2–6].

In general, CT findings that indicate full-thickness bowel wall injury, such as pneumoperitoneum without another known source, oral contrast extravasation, or direct visualization of disrupted bowel wall, indicate an unequivocal requirement for surgery. It has been suggested that other findings of bowel injury, such as focal bowel wall thickening or bowel wall hematoma, indicate the need for close observation but not necessarily immediate surgical exploration without other definitive indications [3].

The clinical significance of isolated injury of the mesentery without associated bowel injury is uncertain, as is the most appropriate management of this injury when found on a CT scan. Previous CT studies of mesenteric injury have included patients with evidence of concurrent full-thickness bowel injury who would unequivocally require surgical management with or without associated mesenteric injury. Other CT studies of isolated mesenteric injuries are limited by small sample size or

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inclusion of CT scans obtained after diagnostic peritoneal lavage, which compromises CT sensitivity for the detection of mesenteric injury [7, 8]. The goals of our study were to determine the spectrum of CT findings of mesenteric injury, to compare CT findings of mesenteric injury with direct surgical observations, and to assess if CT findings can be useful in predicting which patients with mesenteric injury require laparotomy versus clinical observation.

Materials and Methods

All patients in this study were admitted to the Shock–Trauma Center of the University of Maryland Medical System during a period of 5 years and 4 months, from October 1990 to January 1996. The Shock–Trauma data registry was reviewed to identify patients with surgical findings of mesenteric injury sustained from blunt force injury. A trauma radiology database (Access; Microsoft, Redmond, WA) was also reviewed to identify patients with a presurgical CT interpretation that included definite or possible mesenteric injury. All patients with surgically verified mesenteric injury who had abdominal CT done before surgery were included in the study. All patients went to surgery within 24 hr of the initial CT scan except one, whose initial CT scan was interpreted as negative for mesenteric injury. This patient had a subsequent deteriorating clinical course and had an additional CT scan 5 days after admission and immediately before surgery. Patients who had CT findings of mesenteric injury during the study period were included whether they were managed medically or surgically. We excluded laparotomy patients in whom CT showed full-thickness bowel injury concurrent with mesenteric injury (n = 3), patients who had diagnostic peritoneal lavage before CT (n = 2), and patients who did not have a CT scan before surgery (n = 5). Of the 29 patients who met the study criteria, 20 were men and 9 were women; they ranged from 16 to 83 years old (mean age, 39 years old). All patients had a history of blunt abdominal trauma.

We retrospectively reviewed the patients' medical records and surgical reports to determine the patients' symptoms and physical findings, specific findings at surgery, and findings of diagnostic peritoneal lavage if performed before surgery but after CT. Specifically, surgical records were reviewed for the presence or absence of bowel ischemia or perforation and the need for bowel resection as determined at the time of surgery. Surgical records were also reviewed for evidence of active mesenteric bleeding or mesenteric tears requiring repair.

CT scans were obtained on a conventional scanner (HiQ; Siemens, Iselin, NJ) or slip-ring helical scanner (Somatom Plus 4; Siemens). The CT scanner was adjacent to the admitting area of the trauma center. All patients had to be hemodynamically stable, as judged by the admitting clinical service, before transfer to the CT scanner. Scans were obtained with sequential or helical 10-mm collimation at 10-mm intervals through the abdomen followed by sequential 10-mm collimation at 20-mm intervals through the pelvis. All patients received a single dose of oral contrast material (5 g of diatrizoate sodium [Hypaque; Nycomed, New York, NY] powder dissolved in 355 ml of water) and 150 ml of IV iohexol (Omnipaque 240; Winthrop-Breon Pharmaceuticals, Barcolenta, PR) before scanning. The IV contrast material was administered by a power injector (Mark IV; Medrad, Pittsburgh, PA) at a rate of 2–3 ml/sec. A 30- to 40-sec delay was used for conventional scanning, and a 60-sec delay was used for helical scanning. In addition, after helical scanning of the abdomen, a 3- to 5-min delay was used between helical acquisition of the abdominal images (to the level of the iliac crests) and sequential acquisition of the pelvic images to allow for adequate contrast opacification of the bladder.

CT scans were reviewed by two experienced trauma radiologists without knowledge of surgical findings and without consulting the original interpretation. Disagreements were resolved by consensus. The consensus interpretations were later compared with the original interpretations. The scans were reviewed again after the surgical findings were disclosed to determine if subtle findings were present but not recognized on the initial review. CT findings suggestive of mesenteric injury included stranding or opacification of the mesenteric fat (inhomogeneous fluid density), intramesenteric fluid collections (uniform fluid density) or higher attenuation hematoma, free intraperitoneal fluid [9], or evidence of active bleeding within the mesentery and peritoneal cavity. The ranges of CT attenuation values used for the determination of active hemorrhage and clotted blood were 85–370 H and 40–70 H, respectively [10]. Bowel wall thickening of greater than 4 mm was also recorded. Intraperitoneal free air or oral contrast extravasation, if identified on initial interpretation, lead to patient exclusion.

CT observations were correlated with surgical findings to determine the sensitivity of CT for detection of mesenteric injury and the usefulness of CT findings to discriminate mesenteric injuries requiring immediate surgical intervention (mesenteric avulsion with ischemic bowel, actively bleeding mesenteric vessels, and full-thickness tears of the mesentery) from less serious injuries (partial-thickness laceration, focal contusion, stable hematoma, or serosal tear with viable bowel) that could potentially be observed. The surgeon–author, who was present at one third of the surgeries, reviewed the surgical records to determine which injuries required surgery and which potentially did not. The two patients who did not undergo laparotomy were followed up clinically.

Results

Twenty-seven of the 29 study patients underwent laparotomy after CT. The other two patients were managed by observation. Of the 27 patients who had surgery, 24 (89%) had CT findings of mesenteric injury confirmed. Surgical findings showed CT scans to be falsely negative in two other patients and falsely positive in one other patient. No major discrepancies were found between the retrospective CT reviews done with and without knowledge of the surgical findings. The retrospective review and the original CT interpretation disagreed in one case: a scan, originally interpreted as negative, was found to show homogeneous fluid infiltration of the mesentery on retrospective review. This patient subsequently deteriorated, and a follow-up CT obtained 5 days later showed focally thickened small-bowel loops. At surgery, this patient was found to have devitalized bowel requiring resection. The two false-negative CT studies had no direct CT findings of mesenteric injury either by initial interpretation, retrospective review, or repeated review with knowledge of surgical outcome, although one of the two did have intraperitoneal free fluid without a visualized source. Both of these patients had positive diagnostic peritoneal lavage results. (One patient had a distal jejunal mesenteric tear at surgery, and the second had a small mesenteric laceration and pericecal mesenteric hematoma, neither of which required surgical repair.) The falsely positive CT diagnosis of mesenteric injury occurred in a patient with a peripancreatic hematoma related to pancreatic transection that was attributed to an injury of the transverse mesocolon.

On the basis of the 26 surgical cases with verified mesenteric injury, CT was 92% (24/26) sensitive in detecting the mesenteric injury. The two patients followed medically had CT findings of mesenteric fluid density, and one also had a small quantity of free intraperitoneal fluid. Both were managed medically because the clinical examination of the abdomen had benign results and the vital signs and hematocrit were stable. Neither patient required subsequent delayed surgical intervention.

Among the 26 patients with surgically verified mesenteric injuries, 21 had lesions that required immediate surgical intervention, including ischemic bowel (n = 10), actively bleeding or avulsed mesenteric vessels (n = 14), and full-thickness mesenteric injury (n = 11). The other five surgical patients had mesenteric injuries that did not require surgical repair, including partial-thickness mesenteric tears (n = 4), stable mesenteric hematomas (n = 4), or serosal tears with viable bowel (n = 1). Although these injuries were treated at surgery, they could, in the judgment of the surgical team, potentially have been managed

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TABLE 1 CT Findings in 26 Patients with Surgically Proven Mesenteric Injury

CT Signs	No. of Patients (%)	
	Surgery Indicated (n = 21)	Surgery Not Indicated (n = 5)
Active bleeding	6 (29)	0
Bowel wall thickening with associated mesenteric findings	5 (24)	0
Mesenteric fluid or hematoma[a]	12 (57)	3 (60)
Mesenteric infiltration[b]	6 (29)	1 (20)
Free fluid[c]	9 (43)	2 (40)
None of the above	0	1 (20)

Note.—Mesenteric infiltration is defined as inhomogeneous fluid density within the mesenteric fat; intramesenteric fluid collection or hematoma is defined as uniform fluid density of low or high attenuation, respectively.

[a]Without active extravasation of contrast agent.

[b]With neither active extravasation of contrast agent nor mesenteric fluid or hematoma.

[c]Without visceral injury at surgery as possible cause.

conservatively. The CT findings in all surgical cases are summarized in Table 1.

Two CT findings were unique to patients whose injuries required surgical repair: active extravasation of IV contrast material (Figs. 1 and 2), seen in seven cases, and bowel wall thickening associated with mesenteric findings (Figs. 2 and 3), seen in five cases. Among the patients with mesenteric contrast extravasation seen on CT, six of the seven had active mesenteric bleeding at the time of surgery, and five of the seven had ischemic bowel requiring resection. Among the five patients with bowel wall thickening identified by CT, four had ischemic bowel at surgery.

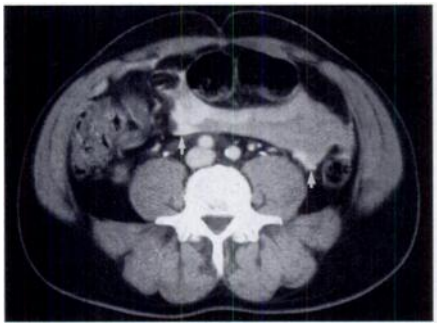
The other CT findings associated with mesenteric injury included mesenteric hematoma (Figs. 3 and 4) and infiltration of the mesentery with fluid density (Fig. 5). Free intraperitoneal fluid without another source, such as visceral injury, identified was not unique to patients whose injuries required surgery but were seen commonly in patients with both surgically (n = 8) and potentially nonsurgically managed (n = 3) mesenteric injuries.

Physical findings did not correlate well with the type and clinical significance of the mesenteric injury. Six patients with benign physical findings but CT findings of mesenteric injury had lesions requiring surgical repair. Among the five patients with injuries not necessarily requiring surgical repair, positive physical findings including diffuse abdominal tenderness (n = 3), rebound tenderness (n = 1), and hypoactive bowel sounds (n = 2) were recorded. Among the remaining 16 patients whose injuries required surgical repair, physical findings were variably present. The two patients managed without surgery had clinical assessments whose results were initially and persistently benign.

Discussion

CT plays a major role in the evaluation of patients with a history of blunt abdominal trauma and suspected mesenteric or bowel injury [1–4]. Our results support the assertion that CT is a sensitive tool for use in the identification of mesenteric injuries without associated full-thickness bowel injuries. Of the 27 surgically proven cases in our study, one had had a false-positive and two a false-negative CT scan for mesenteric injury. The patient with the false-positive CT scan for mesenteric injury nonetheless had sustained a pancreatic transection with peripancreatic hematoma that required surgical exploration. Both patients with false-negative CT scans did have injuries to the mesentery at surgery, but neither required surgical intervention. Therefore, the management of these patients may not have been changed had the CT interpretation been positive.

It has been proposed that CT could potentially be used to discriminate mesenteric and bowel injuries requiring surgical intervention from those that could be managed conservatively [2, 3]. In bowel injury, CT findings consistent with extravasated oral contrast material; direct observation of loss of bowel wall integrity; and free intraperitoneal, intermesenteric, or intramural gas without a known source would indicate a need for urgent surgery. Thickened bowel loops alone in the setting of a clinical abdominal examination with benign results could be observed [2]. In mesenteric injury, this



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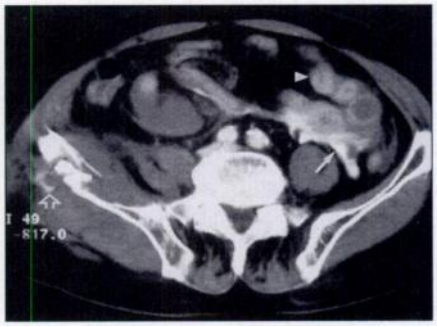

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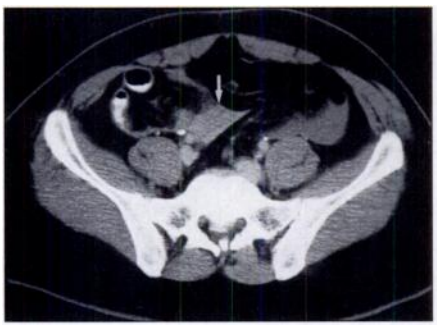
Fig. 1.—41-year-old man with extravasation of vascular contrast agent into mesentery. Enhanced CT scan shows high-density material (*arrows*) within lower density mesenteric hematoma, indicating active bleeding. Active bleeding 10 cm from ileocecal valve was confirmed at surgery. Patient required resection of ischemic and devitalized terminal ileum.

Fig. 2.—83-year-old man with active mesenteric bleeding. CT scan shows active mesenteric bleeding (*arrow*) and adjacent thick-walled loops of bowel (*arrowhead*) as well as active bleeding into gluteal muscle in proximity of right iliac wing fracture (*open arrow*). At surgery, patient required ligation of actively bleeding vessels, and thick-walled bowel was found not to be devitalized.



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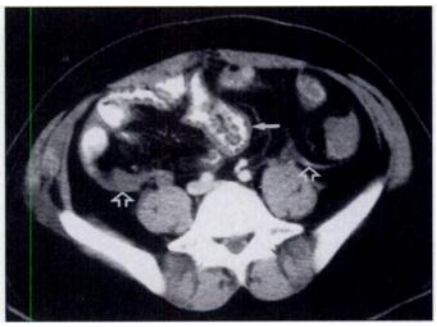

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Fig. 3.—27-year-old man with blunt trauma.

A, Enhanced admission CT scan shows characteristic triangular shape of high-attenuation mesenteric hematoma (*arrow*) caught between adjacent leaves of mesentery. This CT scan was initially interpreted as negative for mesenteric injury.

B, Follow-up CT scan on same patient, who had subsequent deteriorating clinical course, obtained 5 days after admission CT scan shows findings of mesenteric injury associated with ischemic small bowel. Enhanced CT scan shows focal bowel wall thickening (*solid arrow*), thickened folds, and two small foci of intramesenteric fluid (*open arrows*). This section of ileum was found to be devitalized at surgery and was resected.

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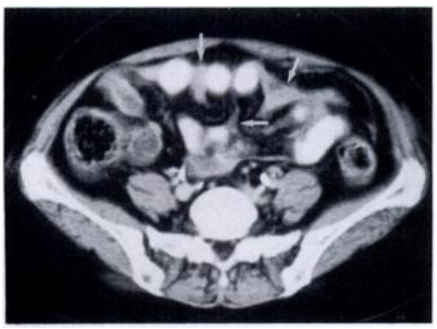

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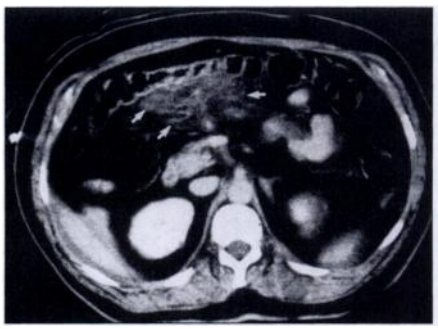

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Fig. 4.—57-year-old woman with intramesenteric hematomas. Enhanced CT scan shows typical triangular hematomas (*arrows*) between mesenteric folds. At surgery, small mesenteric tears were found adjacent to focal hematomas.

Fig. 5.—48-year-old man with infiltration of mesenteric fat. Enhanced CT scan shows opacification of transverse mesocolon (*arrows*). At surgery, this area of mesentery was found to have full-thickness tear and to be bleeding. Adjacent transverse colon had serosal tear and focally ischemic.

study shows that identifying extravasated IV contrast material in the mesentery from vascular injury strongly indicates the potential for vascular compromise of the bowel as well as the potential for ongoing hemorrhage mandating exploration. Similarly, the association of local bowel wall thickening combined with adjacent mesenteric hematoma or mesenteric infiltration in our study also indicates a high likelihood of vascular compromise of the bowel and mandates exploration.

The significance of the less striking signs of mesenteric injury, such as isolated mesenteric hematoma and isolated fluid density within the mesentery, is not clarified by this study. Some patients with these findings (n = 6) did not have mesenteric lesions requiring surgical repair, whereas others (n = 6) had life-threatening bowel ischemia. For this reason, we believe that these CT findings alone should not be used as the sole criteria for determining the need for laparotomy. Patients with mesenteric hematoma or fluid without adjacent bowel wall thickening and without surgical indications from physical examination should be carefully observed, undergo follow-up CT within 24 hr, undergo laparoscopic evaluation [11, 12], or have surgical exploration. Our review of medical records also indicated that initial physical findings alone were a poor guide for deciding between surgical and nonsurgical management of patients with mesenteric injuries.

Conclusion

The CT finding of mesenteric bleeding and bowel wall thickening associated with mesenteric hematoma or infiltration in the blunt trauma victim indicates a high likelihood of a mesentery–bowel injury requiring surgery. The finding of focal mesenteric hematoma or infiltration without adjacent bowel wall thickening is nonspecific and can occur with both mesentery–bowel lesions that require surgery and those that do not. In those that do not, careful clinical observation and follow-up studies including delayed repeat abdominal CT, laparoscopy, or possible exploration are recommended. Our impression was that the use of oral contrast material to make the small-bowel lumen opaque was helpful in identifying mesenteric lesions and bowel wall thickening.

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