

# Blunt Abdominal Trauma with Splenic Laceration Treated by Embolization

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## Abstract

Contrast-enhanced CT imaging remains the gold standard of care for diagnosing blunt splenic injuries in children. Extended focused assessment sonography is commonly performed in the emergency department as an adjunct to physical exams in seriously injured children to evaluate the abdominal cavity for free blood and organ injury. Nonoperative management remains the gold standard for the treatment of blunt splenic injuries in hemodynamically stable pediatric patients. According to recent American Pediatric Surgical Association guidelines, splenic arterial embolization (SAE) is a safe alternative to surgical interventions where hemodynamic stability cannot be achieved by nonoperative management and in hemodynamically unstable children. SAE allows for the preservation of the spleen and maintenance of the immune competence.

**Keywords:** trauma, spleen

## Case Summary

Patient 1 is a school-aged child in MVA, with clinical vital sign instability and decreasing hemoglobin requiring transfusions. This patient underwent a splenic angiogram and splenic artery embolization (SAE) following a CTA of the abdomen and pelvis.

## Imaging Findings

See Figures 1, 2.

## Diagnosis

Blunt abdominal trauma with splenic laceration secondary to a motor vehicle accident (patient 1).

Differential diagnosis includes splenic laceration secondary to falls and sports

injuries in children aged 5-15 and splenic laceration secondary to an assault, that is, nonaccidental trauma, in children under age 5.

## Discussion

Blunt splenic injury (BSI) is the most prevalent blunt injury sustained by children compared with other solid organ injuries like the liver and kidney.<sup>1</sup> Blunt splenic injuries most frequently occur secondary to motor vehicle accidents, but can also result from bicycle accidents, competitive sports, for example, soccer, and falls in children 5-15 years old, and assault and nonaccidental trauma in children under 5 years old.<sup>2</sup> Patients brought to the emergency department under suspicion of a BSI may present with left-sided

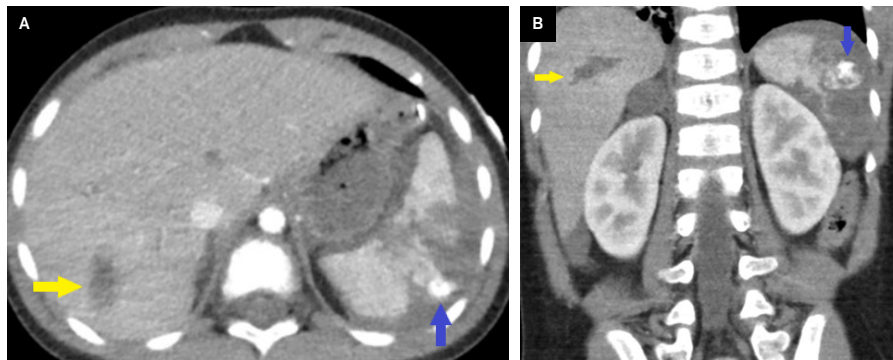
abdominal pain, skin pallor, diminished distal pulses, and left-sided shoulder pain propagated via the phrenic nerve on inspiration; this is due to irritation of the diaphragm by blood.<sup>3</sup>

Prior to recent advancements in medical technology, diagnostic peritoneal lavage (DPL) was the method of choice for diagnosing intra-abdominal hemorrhage. The DPL method has low specificity and can lead to unintentional damage to abdominal organs.<sup>4</sup> While contrast-enhanced CT (CECT) is currently the gold standard of diagnostic imaging for significant trauma, extended focused assessment sonography (E-FAST), contrast-enhanced US (CEUS), and Doppler US (DUS) are additional imaging modalities that can aid in diagnosing and managing BSIs.<sup>4</sup> The E-FAST scan is used as an adjunct to physical examination in the emergency room. The purpose of E-FAST is to rapidly assess trauma patients for the presence of free fluid in the abdomen and pericardium, indicating possible internal bleeding or organ injury. This approach helps identify life-threatening conditions and guide therapy.

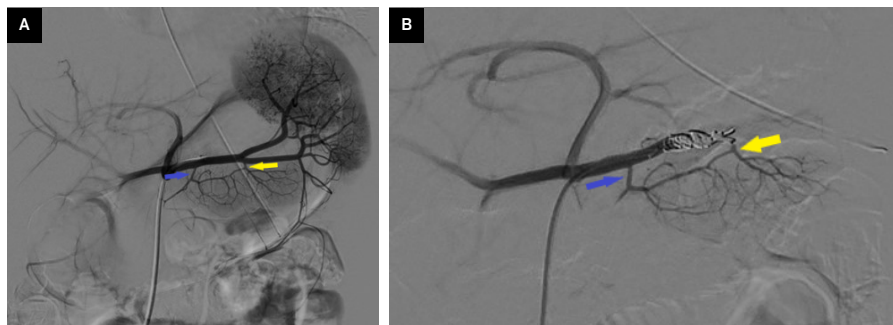
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**Figure 1.** Patient 1: (A, B) contrast-enhanced axial and coronal CT of the abdomen and pelvis demonstrating the presence of a grade 5 splenic laceration with active extravasation from the spleen (blue arrow). Additionally, there is a liver laceration and hemoperitoneum (yellow arrow).



**Figure 2.** (A) Splenic digital subtraction angiogram (DSA) demonstrating heterogeneous opacification of the spleen without active extravasation. However, the splenic contour is not completely seen with nonvisualized portions of the lower pole. Note the dorsal pancreatic artery (blue arrow) and great pancreatic artery (yellow arrow) supplying the pancreatic body and tail. (B) Splenic DSA after coil embolization of the splenic artery between the dorsal pancreatic and great pancreatic arteries, which is performed when the splenic laceration is multifocal.



A CECT provides a diagnostic sensitivity and specificity between 96% and 100%. According to current American Pediatric Surgical Association (APSA) and World Society of Emergency Surgery (WSES) guidelines, CT scans should be reserved for patients who are hemodynamically stable.<sup>4</sup> When utilizing CT imaging, the splenic parenchyma is best evaluated in the portal venous phase.<sup>5</sup> The natural inhomogeneous (psychedelic or zebra) enhancement of the spleen can imitate the appearance of lacerations and contusions when assessed in the arterial phase.<sup>5</sup> Arterial phase assessments are best for identifying vascular pathology. Splenic lacerations appear as linear (branched or unbranched) hypodensities on CECT.<sup>5</sup> Splenic clefts (areas of prominent spleen

lobulation) can mimic lacerations. In contrast to lacerations, splenic clefts have smooth lobular edges and are associated with fat.<sup>6</sup> The detection of hypodense crescentic fluid collection that alters the natural shape of the spleen is indicative of a subcapsular hematoma.<sup>6</sup> Active bleeding can be diagnosed when contrast extravasation that increases in volume on delayed CT imaging is seen.<sup>6</sup> Splenic artery pseudoaneurysms are bulbous arterial protrusions that, while rare, can arise secondary to the injury or after surgical intervention of splenic artery injuries. A 3-D reconstruction of the injured blood vessel can improve the accuracy of diagnosis.<sup>6</sup> Additionally, CT imaging in the arterial phase can aid in the evaluation of pseudoaneurysms.<sup>5,6</sup>

In contrast to CT imaging, E-FAST is recommended for patients who are hemodynamically unstable as a prelude to emergency care or surgery.<sup>4</sup> CEUS and DUS are additional imaging modalities that can be utilized in hemodynamically unstable patients. CEUS is mobile and can be used at bedside. It can aid in the management of splenic trauma with early detection of organ injuries and complications.<sup>7,8</sup> DUS, an effective method for evaluating blood flow, is used in the postoperative evaluation of splenic artery patency.<sup>9</sup>

BSI severity is graded based on either the WSES or the American Association for the Surgery of Trauma (AAST). For conciseness of classification, WSES I, WSES II, WSES III, and WSES IV are equivalent to AAST grades I-II, III, IV-V, and unstable patients graded I-V, respectively.<sup>4</sup> WSES grade I consists of a subcapsular hematoma affecting <10% surface area, a parenchymal laceration <1 cm, and a capsular tear.<sup>4</sup> WSES grade II consists of a subcapsular hematoma affecting 10-50% surface area, an intraparenchymal hematoma <5 cm, and a parenchymal laceration 1-3 cm in depth.<sup>4</sup> WSES grade III consists of a subcapsular hematoma affecting >50% surface area, an intraparenchymal hematoma ≥5 cm, and a parenchymal laceration >3 cm in depth.<sup>4</sup> WSES grade IV consists of vascular injury or active bleeding confined within the splenic capsule, and a parenchymal laceration involving segmental or hilar vessels producing >25% devascularization of the spleen.<sup>4</sup> WSES grade V consists of a shattered spleen, vascular injury, and active bleeding beyond the splenic capsule.<sup>4</sup>

The current APSA guidelines identify nonoperative management (NOM) as the gold standard of care for hemodynamically stable pediatric patients secondary to a BSI.<sup>10</sup> According to the APSA, surgical intervention should be reserved for pediatric patients who present with uncontrolled hemorrhage or remain hemodynamically unstable after NOM

protocols.<sup>10</sup> Splenic artery embolization (SAE) is indicated to treat hemodynamically stable patients while splenectomy is the preferred choice in hemodynamically unstable situations. SAE is minimally invasive and effectively treats post-traumatic bleeding and preserves splenic tissue and immune competence. For these reasons, SAE is the procedure of choice as preservation of the spleen is ideal for the pediatric population and is associated with lower morbidity and mortality rates.<sup>2</sup> Splenectomies are more likely to be complicated by post-splenectomy infection and longer hospital stays.<sup>2,11</sup> The approach to treatment should be determined on a case-by-case basis between the surgery and interventional radiology departments.<sup>4</sup>

Treatment of vascular injuries is best accomplished with collaboration between the surgeons and interventionalists.<sup>10,12</sup> WSES grade I injuries are generally treated with NOM. WSES grade II injuries can either be treated with either NOM or SAE. WSES grade III-IV injuries are ideal candidates for treatment with SAE.<sup>10</sup>

## Conclusion

CECT imaging remains the gold standard of care for diagnosing blunt

splenic injuries in children. E-FAST is commonly performed in the emergency department as an adjunct to physical exams in seriously injured children to evaluate the abdominal cavity for free blood and organ injury. NOM remains the gold standard for the treatment of blunt splenic injuries in hemodynamically stable pediatric patients. According to recent APSA guidelines, SAE is a safe alternative to surgical interventions where hemodynamic stability cannot be achieved by NOM and in hemodynamically unstable children. SAE allows for preservation of the spleen and maintenance of the immune competence.

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