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## Case Report

# Delayed diagnosis of a flexion-distraction spinal injury and occult small bowel injury in a pediatric trauma patient: Importance of recognizing the abdominal “seatbelt sign”

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## ABSTRACT

Spine trauma in the pediatric population can present with occult spinal and visceral injuries, presenting unique diagnostic challenges. Subtle imaging findings, as well as difficulty in patient participation with history and examination can contribute to a delayed or missed diagnosis. This in turn can be detrimental to recovery, leading to significant delay in care, additional morbidity, and cost.

We present the case of an 11-year-old female patient with a delayed diagnosis of an unstable three-column lumbar spine injury as well as an occult small bowel injury that evaded diagnosis despite multiple hospitalizations and a plethora of imaging and treatment modalities. This led to several extended hospital stays and numerous interventions and surgeries to treat her injuries. We present this case to highlight the sequela of such an injury, and to broaden awareness across specialties of an injury pattern which requires a heightened index of suspicion to detect.

## Introduction

Flexion-distraction injuries (FDI) of the spine, are caused by a mechanism of forward flexion of the torso with the abdomen or thorax as the fulcrum. FDI are frequently associated with seat belts which act as the anterior restraint, particularly if the shoulder strap is not properly positioned (Fig. 1). This causes compression on the anterior to middle columns of the spine with a distraction force through the posterior column, injuring bony and soft tissue structures creating spinal instability. The thoracolumbar junction and lumbar spine are most commonly affected, as this area of the spine is mobile enough to allow the forces necessary to cause the injury. FDI, also known as a Chance fracture, is commonly associated with concomitant visceral injury, compounding the potential morbidity [1–3]. This injury pattern, especially in the pediatric population, is commonly missed and can lead to significant morbidity and delays in care [2–4]. We present the case of a missed FDI in a pediatric patient, and her subsequent morbidity, to exemplify the significance of these injuries.

## Case report

An 11-year-old female patient was a restrained rear-seat passenger involved in a motor vehicle crash (MVC) in which the driver rear-ended a commercial truck at highway speeds. Initially she was stable and ambulatory, therefore she was transported to a local

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emergency department (ED), trauma level four, where she underwent trauma workup including computed tomography (CT) scans of the head, cervical spine, and chest/abdomen/pelvis (with IV contrast). Of note, two other passengers in the car were taken to the state's only level one pediatric center after on-scene triage and subsequently diagnosed with spine injuries. Transport and transfer decisions were made in accordance with state protocol.

Her presenting exam was notable for anterior abdominal and posterior lumbar pain at both rest and on palpation, with presence of a "seatbelt sign" abrasion across the abdomen. She was hemodynamically stable with imaging read as negative and she was discharged from that ED. Six days later she presented to a different ED for continued low back and abdominal pain, with decreased bowel movements. Repeat abdominal CT was concerning for possible small bowel obstruction, prompting transfer to the state's tertiary pediatric hospital for evaluation. Her abdominal CT scan was again reviewed, this time by a board-certified pediatric radiologist, confirming the obstruction and stating there were no skeletal injuries. Patient underwent diagnostic laparoscopy, which revealed no evidence of trauma or obstruction, and was discharged the next day.

Two days later she presented to our ED with vomiting. Acute abdominal X-rays were concerning for post-operative ileus versus obstruction, without mention of skeletal injury. She was admitted for hydration and continued evaluation. On post-injury day 11, repeat CT was obtained with findings of post-op ileus versus obstruction, and spinous process widening at L3–4 with possible endplate fracture concerning for ligamentous injury. Orthopaedic surgery was consulted. Spine exam revealed tenderness to palpation with a palpable step-off and boggy between spinous processes in the lumbar spine, without neurological deficit. Spinal magnetic resonance imaging (MRI) demonstrated FDI at L3–4, with edema in the posterior elements and facet joint diastasis, but no compression or hematoma of the nerve roots (Fig. 2). She was then taken to the operating room for surgical stabilization with reduction of the posterior elements and instrumented posterior spinal fusion at L3–4 (Fig. 3). Despite stabilization of her spine, her bowel symptoms persisted and by post-injury day 20 still was unable to tolerate PO intake. Over the next 18 days she was seen by gastroenterology and underwent a small bowel follow-through, esophagogastroduodenoscopy (EGD) and IR-assisted nasogastric (NG) tube placement with no improvement or further diagnosis. PICC line was placed and parenteral nutrition initiated. On post-injury day 38, she was discharged on clear liquids, total parenteral nutrition (TPN), and bowel rest.

She was re-admitted two days later with recurrent abdominal pain. Abdominal CT angiography was performed, which revealed flow changes in a portion of mesentery, with findings of jejunal obstruction. On repeat diagnostic laparoscopy multiple small bowel strictures with fibrosis were found (Fig. 4) and the procedure was converted to an open laparotomy with small bowel resection and three stricturoplasties. Post-operative course was complicated by post-operative ileus, febrile episodes, and peritonitis leading to intra-abdominal abscess and incisional seroma. These complications required NG tube placement twice, new PICC line placement, TPN initiation with broad spectrum antibiotics and placement of three drains via interventional radiology. By post-injury day 57, PICC line and drains were removed, PO intake increased and she was discharged.

Six days later she returned febrile with diarrhea and abdominal pain. CT scan was negative, but she was admitted after positive *Clostridium difficile* culture and started on oral vancomycin, discharging the following day. These symptoms recurred 18 days later and oral vancomycin was resumed. At her 4-month follow-up, her spinal fusion was radiographically progressing, and oral intake improved with 10kg of weight gain since discharge.

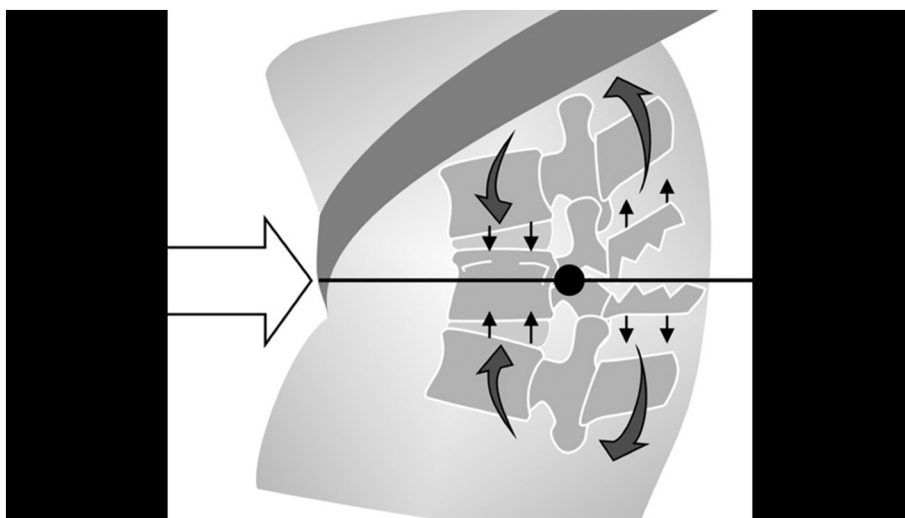


Fig. 1. Diagram illustrating the forces encountered during flexion distraction injuries.

Adapted from Chance-Type Fractures of the Thoracolumbar Spine: Imaging Analysis in 53 Patients, Mark P. Bernstein, the American Journal of Roentgenology Volume 187 Number 4 Copyright© 2006, American Roentgen Ray Society.



**Fig. 2.** Sagittal CT and T2 STIR Sagittal MRI images of the lumbar spine highlighting edema through the posterior ligamentous complex confirming flexion-distraction injury at L3-L4.



**Fig. 3.** Pre-operative images showing the facet diastasis and spinous process widening at L3–4 and post-operative radiographs of the lumbar spine showing reduction and stabilization with instrumented posterior spinal fusion.

## Discussion

We present this case report to draw attention to an injury pattern in children that can prove difficult in diagnosis and treatment. Missed FDI is not an uncommon event, with reported misdiagnosis of 71%, and initial mistreatment of 14% [2]. Lumbar FDI also has a rate of associated injuries cited up to 80%, largely consisting of abdominal injuries localized to the bowel and mesentery [4,5]. Later it was discovered our patient wore her shoulder strap under the armpit, functioning similar to a lap belt which has high association with FDI<sup>3</sup>. This likely contributed to her seatbelt sign on physical exam, known to be a harbinger of abdominal injuries [4]. Given her mechanism and complaints, her imaging should have been scrutinized in regards to the spine and viscera. We suspect that since her spinal injury was purely ligamentous, it proved more difficult to diagnose radiographically despite spinous process and facet joint diastasis being evident in all imaging.

In this particular case, her visceral injury was very difficult to diagnose utilizing cross-sectional imaging and diagnostic laparoscopy. CT is the mainstay of diagnosis, with surgical exploration having a lower specificity but ultimately an extremely low rate of

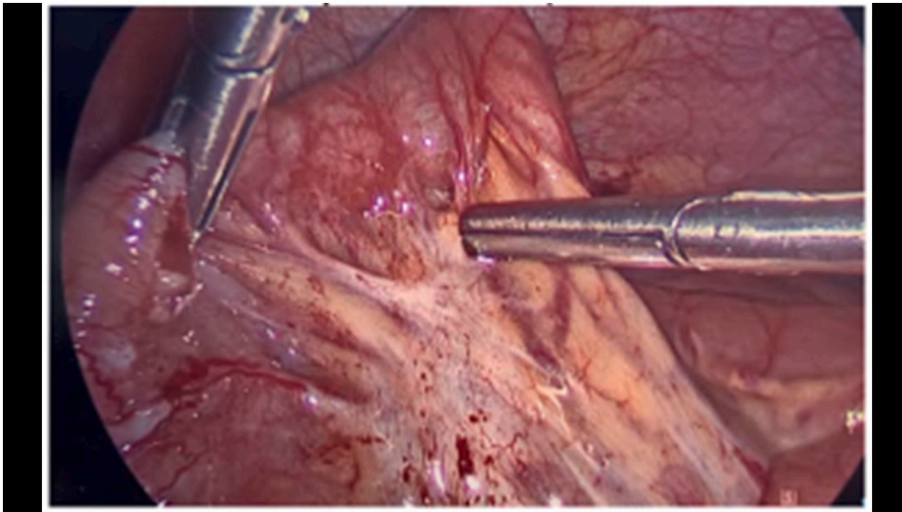


Fig. 4. Intra-operative photo of fibrosis of the mesentery and bowel, causing narrowing in the ileum which was resected and anastomosed.

missed injuries [6,7]. Despite this, her bowel injury evaded diagnosis for some time, emphasizing the need for increased index of suspicion for bowel injury with this constellation of symptoms and mechanism. Importantly, our patient did not receive oral contrast which is advocated for in the workup of children with suspected bowel injury [8]. Given this experience we would emphasize oral contrast use in patients undergoing trauma workup with a mechanism associated with bowel injury. Late presenting bowel stricture is rare, but a known complication from blunt abdominal injury and should remain in the differential diagnosis [9].

The radiation exposure to our patient due to delayed FDI and bowel injury diagnosis was significant with diagnostic and interventional studies totaling of 58.05 mGy; the annual workplace dose limit per the International Commission on Radiological Protection (ICRP) is 20 mGy [10].

We emphasize a high index of suspicion for spine and small bowel injuries in the setting of a seatbelt sign or mechanism of injury associated with FDI and bowel injury. Doing so will create a relevant differential diagnosis and assist providers in an appropriate workup. It is also important to maintain close working relationships between spine surgeons, radiologists, emergency and general surgery/trauma physicians to avoid missing these injuries.

#### Declaration of competing interest

Derrick A. Henry, MD- none.

Richard E. McCarthy, MD- Medtronic: teaching and consulting; Orthopediatrics: teaching and consulting.

David B. Bumpass, MD- Medtronic: teaching and consulting; Orthopediatrics: teaching and consulting.

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