



Computed tomographic imaging in the pediatric patient with a seatbelt sign: still not good enough☆☆☆



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ABSTRACT

Purpose: Considering the improvements in CT over the past decade, this study aimed to determine whether CT can diagnose HVI in pediatric trauma patients with seatbelt signs (SBS).

Methods: We retrospectively identified pediatric patients with SBS who had abdominopelvic CT performed on initial evaluation over 5 1/2 years. Abnormal CT was defined by identification of any intra-abdominal abnormality possibly related to trauma.

Results: One hundred twenty patients met inclusion criteria. CT was abnormal in 38/120 (32%) patients: 34 scans had evidence of HVI and 6 showed solid organ injury (SOI). Of the 34 with suspicion for HVI, 15 (44%) had small amounts of isolated pelvic free fluid as the only abnormal CT finding; none required intervention. Ultimately, 16/120 (13%) patients suffered HVI and underwent celiotomy. Three patients initially had a normal CT but required celiotomy for clinical deterioration within 20 h of presentation. False negative CT rate was 3.6%. The sensitivity, specificity and accuracy of CT to diagnose significant HVI in the presence of SBS were 81%, 80%, and 80%, respectively.

Conclusions: Despite improvements in CT, pediatric patients with SBS may have HVI not evident on initial CT confirming the need to observation for delayed manifestation of HVI.

Level of Evidence: Level II Study of a Diagnostic Test.

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The addition of seatbelts to automobiles has proven invaluable in decreasing mortality from motor vehicle collisions as children who used seatbelts suffered from less devastating head and thoracic injuries [1]. However, abdominal seatbelt usage brings about an additional distinctive injury profile termed “the seatbelt syndrome” resulting from a rapid deceleration causing hyperflexion of the torso and compression of the abdominal contents on the seatbelt. Injury pattern includes abdominal wall ecchymosis, injury to the intestinal viscera and spinal fractures [2]. Since first described decades ago, the presence of a seatbelt sign (SBS) has been repeatedly shown to increase the likelihood of abdominal and intestinal injuries [3–5].

As seatbelts were designed for the adult habitus, improper belt placement secondary to positioning or lack of a booster seat contributes greatly to preventable seatbelt injuries in children, nearly twice the risk of injury compared with properly restrained children [6]. Lap belts are designed to fit over the anterior superior iliac spines of the pelvis to prevent forward motion of the lower body and absorb deceleration forces into the bony pelvis rather than the abdomen. However, it appears most injuries occur when the seatbelt is either resting too high across the abdominal wall or from slippage of the belt above the anterior superior iliac crests and onto the abdominal wall [7].

Prior research has shown a lack of reliability of physical examination in the presence of an abdominal seatbelt sign in the pediatric patient [5]. In addition, the FAST exam, when evaluating patients after blunt abdominal trauma with a seatbelt sign, had a sensitivity of less than 75% for detecting clinically significant injury [8]. Computed tomographic imaging (CT) is typically the imaging modality of choice to evaluate stable pediatric patients after blunt abdominal trauma, yet, even its reliability to identify hollow viscus injury remains uncertain. As a result, the 2002 Eastern Association for the Surgery of Trauma guideline on blunt abdominal trauma stated that patients with a seatbelt sign required hospital admission despite normal radiographic evaluation presumably

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motivated by concern for occult hollow viscus injury [9]. Considerable improvements in CT technology have occurred during the past two decades leading to improvement in image quality with decreased electronic noise, finer image resolution and multi-planar reconstructions. Considering the advances in CT over the past decade, this study aimed to determine if CT can now reliably diagnose hollow viscus injury in pediatric trauma patients with a seatbelt sign.

1. Methods

After receiving institutional review board approval, we identified all pediatric patients less than 15 years old with a documented seatbelt sign after motor vehicle collision that had abdominopelvic CT performed on initial evaluation at our ACS-verified Adult Level I and Pediatric Level II Trauma Center. This was a retrospective review of patients identified within the trauma database over a 5 1/2-year period (July 2010–December 2015) where seatbelt sign was defined as abdominal ecchymosis or abrasion due to seatbelt use.

Radiographic images were reviewed prospectively by an attending radiologist who indicated whether they interpreted any intra-abdominal abnormality possibly related to trauma. For the purpose of this study, solid organ injury included injury to the liver, spleen, pancreas and kidney while hollow viscus injury encompassed injury to the gastrointestinal tract and its' associated mesentery. Specific findings indicative of hollow viscus injury at CT were pneumoperitoneum, unexplained intraperitoneal fluid, bowel wall changes, mesenteric changes, and/or mesenteric extravasation of contrast.

CT scans of the abdomen and pelvis were performed on a General Electric Light Speed 16-slice system (Milwaukee, WI) or a Phillips iCT 256-slice system (Cleveland, OH) throughout the duration of the study. Image Gently® principles were used throughout the time period of this study. Intravenous (Isovue 360) contrast was utilized in all cases with a delay of 70 s. No oral contrast was given for initial imaging. The

images were acquired in standard soft tissue algorithm with a slice thickness of 1.25 mm at 2.5 mm intervals using a smart milliampere (mA) program that was weight based with coronal and sagittal reformats.

Outcomes, measured at 24 h and/or time of discharge, included clinical deterioration and/or need for celiotomy. The sensitivity, specificity and accuracy of CT to diagnose significant hollow viscus injury in the presence of a seatbelt sign was defined by the subsequent need for intervention or the delayed identification of an intra-abdominal injury. The decision to proceed with operation for each patient initially was made by the attending trauma surgeon. Once admitted, subsequent decisions in care, including follow up imaging or surgical intervention, were made at the discretion of the pediatric surgeon overseeing the pediatric trauma service.

Comparisons and analysis between groups were performed using Student *t* or chi-square tests where appropriate. A *p* value of <0.05 was defined as statistically significant.

2. Results

One hundred and twenty patients met inclusion criteria during the study period. Ages ranged from 3 to 14 years (median 9, IQR 5), 53% were male, and ISS ranged from 1 to 45 (median 1, IQR 4). Associated chest and neck seatbelt sign were seen in 28% and 22% of patients, respectively. CT evidence of soft tissue change consistent with the areas of ecchymosis or abrasion ("CT seat belt sign") was observed in 22 patients (18%) and was more likely to be radiographically evident with ecchymosis (24%) than with abrasion (18%) though this did not reach statistical significance. Importantly, a hollow viscus injury requiring operative intervention was more likely to occur when a CT seatbelt sign was evident on imaging (27% versus 10%, *p* = 0.03).

Overall, CT was abnormal in 38/120 (32%) patients: 34 scans had evidence of hollow viscus injury and 6 showed solid organ injury. In

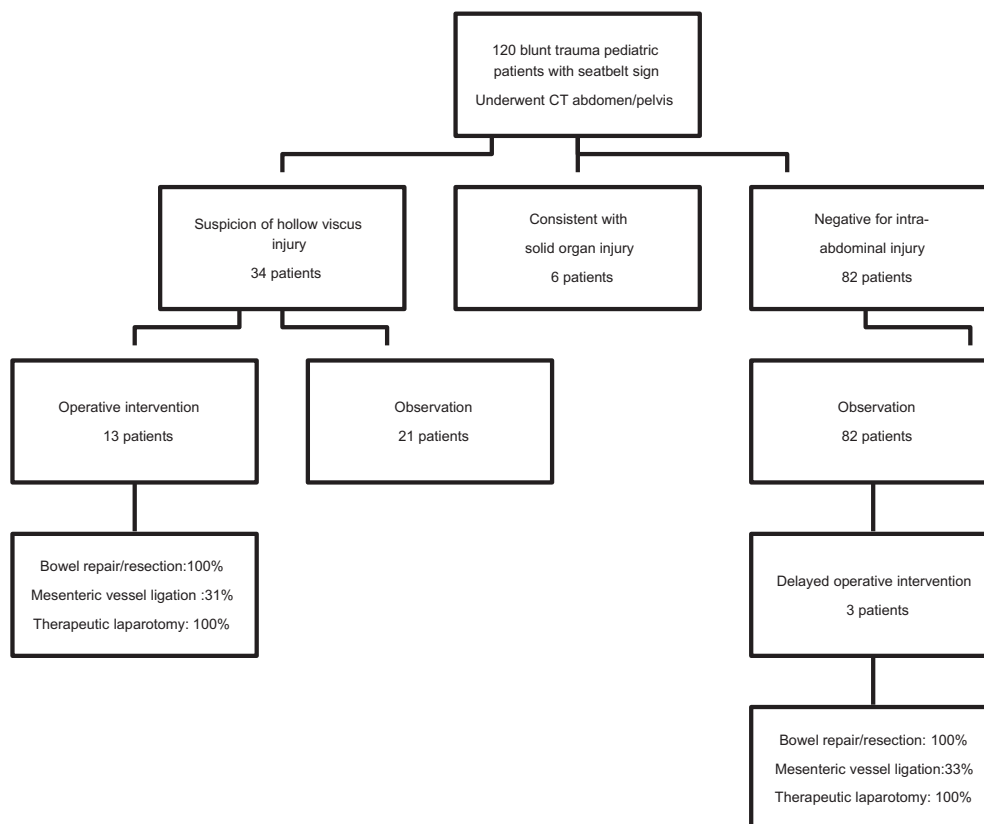


Fig. 1. Imaging results and treatment.

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