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## Original Contributions



### PHYSICAL EXAMINATION IS THE BEST PREDICTOR OF THE NEED FOR ABDOMINAL SURGERY IN CHILDREN FOLLOWING MOTOR VEHICLE COLLISION

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**Abstract—Background:** Exploratory laparotomy in children after motor vehicle collision (MVC) is rare. In the absence of definitive hemorrhage or free abdominal air on radiographic imaging, predictors for operative exploration are conflicting. **Objective:** The purpose of this study was to explore objective findings that may aid in determining which children require operative abdominal exploration after MVC. **Methods:** Data from 2010–2014 at an American College of Surgeons–certified level 1 pediatric trauma center were retrospectively reviewed. Demographics, vital signs, laboratory data, radiologic studies, operative records, associated injuries, and outcomes were analyzed and  $p < 0.05$  was considered statistically significant. **Results:** Eight hundred sixty-two patients 0–18 years of age presented to the hospital after an MVC during the study period. Seventeen patients (2.0%) required abdominal exploration and all were found to have intraabdominal injuries. Respiratory rate was the only vital sign that was significantly altered ( $p = 0.04$ ) in those who required abdominal surgery compared with those who did not. Physical examination findings, such as the seat belt sign, abdominal bruising, abdominal wound, and abdominal tenderness, were present significantly more frequently in those requiring abdominal surgery ( $p < 0.0001$ ). Each finding had a negative predictive value for the need for operative exploration of at least 0.98. There were no significant differences in trauma laboratory values or radiographic findings between the 2 groups. **Conclusion:** Data from this study solidify the relationship

between specific physical examination findings and the need for abdominal exploration after MVC in children. In addition, these data suggest that a lack of the seat belt sign, abdominal bruising, abdominal wounds, or abdominal tenderness are individually predictive of patients who will not require surgical intervention. © 2017 Elsevier Inc. All rights reserved.

**Keywords—**children; injury; motor vehicle crash; seat belt sign

#### INTRODUCTION

Unintentional injury is the leading cause of death in children >1 year of age, and motor vehicle collision (MVC) is the leading cause of death in children 8–18 years of age (1,2). Seat belt use is a crucial method to decrease the risk of severe injury and death in children involved in MVC (3,4). However, shortly after the introduction of seat belts in 1960, the “seat belt syndrome” was described—a combination of abdominal wall bruising (AWB), intra-abdominal injury (IAI), and lumbar spine fracture—raising concern that seat belts may cause a unique set of injuries (5). Subsequently, multiple reports found that a positive seat belt sign (SBS) was associated with an increased risk for IAI (6–11). In addition, children remain at increased risk for seat belt–related injury caused by improper restraint use (12,13). The

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probable mechanism of seat belt injury is direct loading over the injured organ (14).

The optimal evaluation algorithm to identify blunt IAI in the pediatric population includes a combination of history and physical examination findings, laboratory values, and imaging modalities (15–21). The majority of pediatric blunt IAIs are managed conservatively; however, the need for abdominal exploratory surgery persists in select circumstances.

Literature describing predictive factors for the need for abdominal exploratory surgery in pediatric patients presenting with blunt trauma after MVC is scarce. A study of 1400 patients over a 3-year period at a major trauma center concluded that SBS was associated with a higher incidence of IAI (9). Likewise, Paris et al. concluded that associated lumbar fracture, free intra-abdominal fluid, and tachycardia were highly predictive of intestinal injury in children with AWB and the need for laparotomy after MVC (8). However, this study was limited to patients presenting with AWB and may have missed patients with IAI in the absence of this physical examination finding. Other studies have presented conflicting data, and have suggested that the SBS is not associated with an increased risk of abdominal injury or need for abdominal surgery (22,23).

The objective of the present study was to determine predictive factors associated with the need for abdominal exploratory surgery in children sustaining blunt abdominal injury after MVC. We hypothesized that a combination of laboratory, physical examination, and radiographic findings would be predictive of the need for operative intervention in children with blunt abdominal trauma.

## METHODS

### *Patient Selection*

A single-center retrospective query of the pediatric trauma database was performed for all blunt trauma-related encounters incurred over a 5-year period between January 1, 2010 and December 31, 2014. Institutional review board approval was obtained before the search. Patient medical records were assessed for demographic variables and initial vital signs, physical examination findings, laboratory values, and trauma-related imaging results. These were compiled into a master database. Patients were subsequently divided into those who underwent abdominal surgery for their injuries and those who did not undergo abdominal surgery.

### *Assessed Variables*

Continuous variables were considered in 2 groups: initial vital signs (i.e., heart rate, systolic and diastolic blood

pressure, temperature, unassisted respiratory rate, and Glasgow coma scale) and initial trauma laboratory panel (i.e., hemoglobin, hematocrit, white blood cell count, aspartate transaminase, alanine transaminase, amylase, and lipase). Vital signs and laboratory values were additionally considered as binomial variables, categorized into normal and abnormal variables. Other categorical variables included physical examination findings (i.e., presence or absence of the SBS, abdominal bruising (AB), abdominal tenderness, or open abdominal wound) and radiographic findings on computed tomography (free pelvic fluid or pneumoperitoneum).

### *Statistics*

Continuous variables were expressed as mean  $\pm$  the standard error of the mean and were compared using Student's *t*-test. Categorical variables were compared using chi-squared tests.  $p < 0.05$  was considered statistically significant.

## RESULTS

### *Patient Population*

Eight hundred sixty-two patients ranging from 0–18 years of age were assessed in the hospital after MVC during the study period. Eight hundred fifty-seven patients had complete medical records, including documentation of physical examination findings and laboratory values of interest; these patients form the basis of this report. Seventeen patients (2.0%) required abdominal exploration while 840 did not require an abdominal procedure.

### *Operative Findings*

Seventeen patients (2%) underwent operative intervention. Of these patients, 15 (88%) were identified appropriately on their first admission and operated on immediately after trauma. Two of 17 patients (12%) exhibited none of the physical examination findings of interest. One patient was discharged and readmitted 4 days later with a delayed presentation of a jejunal perforation. The other patient presented in a delayed fashion with small bowel obstruction 12 days after trauma. Each patient who underwent surgical intervention was found to have an IAI (Table 1). There were no negative laparotomies.

### *Vital Signs*

Initial recorded heart rate, blood pressure, temperature, and Glasgow coma scale were not significantly different between those children requiring operative intervention

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