



## Original Research

## Outcome of children with blunt liver or spleen injuries: Experience from a single institution in Korea



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## HIGHLIGHTS

- Management of blunt solid organ injuries has changed from surgical to nonoperative management.
- Emergence of pediatric trauma centers has led to improved outcomes in children with injuries.
- In Korea, there are few dedicated ATCs and no PTCs.
- Studies concerning the treatment of children with solid organ injury are rarely reported in Korea.

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## ABSTRACT

**Introduction:** The aim of this study is to evaluate the demographics, injury pattern, and treatment outcomes among children hospitalized for the management of blunt liver and spleen injury at a single institution in Korea, and to document trends in treatment strategies of children with blunt torso trauma. **Methods:** Children (<20 years) with blunt liver and spleen injuries, hospitalized at our center between May 2010 and February 2016, were included in the present study. Data were retrospectively analyzed for demographic and injury-related information were obtained. **Results:** During the study period, 34 patients with blunt liver injury and 21 patients with blunt spleen injury presented at the center. The most common cause of liver and spleen injury was motor vehicle collision, followed by fall. Thirty patients (88.2%) with liver injuries and 18 patients (85.7%) with spleen injuries were managed conservatively. No cases of mortality occurred in patients with spleen injury group; one patient (2.9%) died in patients with liver injury due to uncontrolled bleeding.

**Conclusions:** Our data demonstrated that 85.7% of patients with spleen injuries and 88.2% of patients with liver injuries were managed nonoperatively. Operative management was chosen more selectively, being applied in patients with high grade organ injury scores or abrupt changes in vital status. Our findings will contribute to the available data concerning children with traumatic injuries in Korea.

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## 1. Introduction

Blunt abdominal trauma accounts for more than 90% of all pediatric injuries. The spleen and liver are the most commonly injured organs during blunt force trauma [1]. Abdominal bleeding due to intra-abdominal organ trauma is an immediately life-threatening injury. In the past, operative management has played the primary role in controlling abdominal bleeding. During recent

decades, the management of blunt solid organ injuries has changed from an aggressive surgical approach to nonoperative management (NOM) [2–5]. Current success of NOM for blunt solid organ injuries is made possible by the availability of simple and prompt assessment using radiology tools such as computed tomography and focus assessment with sonography for trauma. Furthermore, advances in interventional radiology play an important role in NOM of solid organ injuries. The emergence of pediatric trauma centers (PTCs) has led to improved outcomes in children with injuries compared to adult trauma centers (ATCs) or mixed trauma centers [6–8]. Although some reports have demonstrated the benefits of PTCs, most children with traumatic injuries cannot receive care at PTCs. Reasons for lack of access include a geographically limited distribution, lack of pediatric surgeons and other appropriate

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specialists, and lack of proper resources to treat injured children [9,10].

In Korea, there are few dedicated ATCs and no PTCs. Furthermore, there are no specialists trained in the treatment of injured children. Studies concerning the treatment of children with solid organ injury are rarely reported in Korea [11]. The aim of this study is to evaluate the demographics, injury pattern, and treatment outcomes among children hospitalized for the management of blunt liver or spleen injury at a single institution in Korea, and to document trends in treatment strategies of children with blunt torso trauma.

## 2. Material and method

### 2.1. Study design

This study received approval from the Research Ethics Board at our hospital (HP IRB 2016-11-006). All pediatric trauma patients were identified through the trauma database at single regional hospital between May 2010 and February 2016. Inclusion criteria were age less than 20 years, blunt liver or spleen injury, and admitted for greater than one day from our emergency room. Patients who underwent surgery for intraabdominal injuries involving organs other than the liver or spleen or who suffered mortality due to injuries to organs other than the liver or spleen were excluded. If a patient was diagnosed with both spleen and liver injuries, we included the organ with higher grade injury in the analysis. Decision for treatment method and operation were determined by three surgeons had clinical experience of at least five years after acquiring professional qualifications.

### 2.2. Data collection

From the emergency room database, demographic and injury-related information were obtained, including age, sex, cause of injury, Abbreviated Injury Scale (AIS) codes, Injury Severity Score (ISS), vital signs in the emergency department, initial hemoglobin level in the emergency department, amount of packed red blood cell (pRBC) transfusion within two days of admission, treatment method, admission to the intensive care unit (ICU), duration of stay in the hospital and ICU, and mortality. Treatment methods were classified as operative management versus NOM. Embolization was included in NOM because the method is a less invasive technique.

### 2.3. Statistical analysis

Quantitative data are reported as mean, standard deviation (SD), minimum value, and maximum value. Qualitative data are reported as frequency and percentage. All data were analyzed using SPSS version 21.

## 3. Results

### 3.1. Patient characteristics

A total of 105 patients with spleen injury and 213 patients with liver injury were diagnosed between May 2010 and February 2016 at our hospital. After exclusion of patients over age 20, there were 23 patients with spleen injury and 39 patients with liver injury. In the final analysis, 21 patients with spleen injury were included after exclusion of one patient with pancreatic injury and one patient with liver injury that was comparatively more severe than the splenic injury. A total of 34 patients with liver injury were included after the exclusion of one patient who underwent surgery due to bowel injury, two patients who underwent splenectomy, one

patient who underwent nephrectomy, and one patient with mortality due to brain injury.

The most common cause of liver injury was motor vehicle collision, reported in 18 cases (52.9%), followed by fall (9, 26.5%), and other causes (7, 20.6%). Most patients had a grade II (12, 35.3%) or grade III injury (12, 35.3%), while grades I, IV, and V injuries were present in 3 (8.8%), 4 (11.8%), and 3 (8.8%) patients, respectively. The reported causes of spleen injuries were traffic accidents in 13 (61.9%), fall from a height in 5 (23.8%), and other causes in 3 cases (14.3%). Grade II (8, 38.1%) and grade IV (6, 28.6%) spleen injuries were most common, followed by grade III (4, 19.0%), grade V (2, 9.5%), and grade I (1, 4.8%). A mean ISS of 20.4 (range, 4–50) was recorded for both liver and spleen injury (Table 1).

### 3.2. Patient outcomes

Thirty patients (88.2%) with liver injury and 18 patients (85.7%) with spleen injury were managed conservatively. The average duration of hospital stay was 22.1 days (range, 2–90 days) for patients with the liver injury and 22.2 days (range, 3–90 days) for the spleen injury (Table 2). Embolization was performed in two patients with grade IV spleen injury, two patients with grade III spleen injury, and one patient with grade IV liver injury. Splenectomy was performed in two patients with grade V injury and one patient with grade IV injury. In the patient with grade IV injury, initial vital status was stable and initial hemoglobin was within the normal range. However, while awaiting treatment, the patient's vital status became abruptly unstable, and the hemoglobin level dropped to about 4 mg/dL. Gauze packing and liver suture were performed in three patients with liver injury, and one case of lateral segmentectomy was performed in patients with liver injury. No cases of mortality occurred in patients with spleen injury; one patient (2.9%) died in patients with liver injury due to uncontrolled bleeding (Table 2).

## 4. Discussion

Motor vehicle collisions (passenger in a motor vehicle collision or pedestrian hit by a car) and falls are the most common causes of intraabdominal injury in children [12–14]. Among solid organ injuries, the liver and spleen are most commonly involved. Severe organ injury can lead to hemodynamic instability; in these cases, interventional treatment such as surgery, embolization, and transfusion may be required. In our institution, the most common cause of injury to the spleen and liver were motor vehicle collision, followed by falls. Embolization was performed in five patients (two patients with grade IV spleen injury, two patients with grade III spleen injury, and one patient with grade IV liver injury). Splenectomy was performed in two patients with grade V injury and one patient with grade IV injury. Among patients with liver injury, damage control surgery was performed in three cases and lateral segmentectomy was performed in one patient.

The majority of hemodynamically unstable patients should undergo immediate surgery. Currently, the rate of immediate operative treatment of solid organ injuries ranges from 18.7% to 33% [11,15–17]. During recent decades, multiple studies have shown that NOM of solid organ injuries in hemodynamically stable patients is effective, with a success rate of >90% reported in the field of pediatrics [15,17–19]. The rate of NOM of blunt liver injury ranges from 50% to 85% of all such injuries reported, with an overall success rate that exceeds 80% in many institutions [20–23]. Among blunt splenic injuries, NOM ranges from 76.8% to 95%, with an overall success rate that exceeds 90% [6,24,25]. Compared to non-pediatric trauma centers, pediatric trauma centers are more likely to conservatively manage solid organ injuries in children [6,26].

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