Short Communication

Handlebar Injuries in Children: 20 Years of Experience at A Level I Pediatric Trauma Center

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Abstract

Background: Handlebar injuries in the pediatric population have been shown to cause devastating intra-abdominal injuries. We analyzed the impact of handlebar injuries in our pediatric trauma patients over the past 20 years.

Methods: We reviewed all of the pediatric bicycle accidents ages 15 years old or younger, who required hospitalization for their injuries. Data was collected from 1995 to 2015. Each case was evaluated for mechanism and severity of injuries, physical and radiographic findings, treatment administered length of hospitalization and patient outcomes. Institutional Review Board approval was obtained.

Results: There were 83 pediatric bicycle accidents, which required hospital admission over the past twenty years. 20 out of the 83 patients (24%) sustained direct handlebar injuries. There were 15 males and 5 females ranging from age of 5 to 15 years old (mean 10.3 ± 2.55). Type of injuries included traumatic hernia, bony fractures, and multiple solid organ injuries: spleen (5), liver (3), kidney (2), pancreas (3), and adrenal (1). Most patients were successfully managed non-operatively with close ICU monitoring. Two patients required surgical intervention for traumatic Spigelian hernia and duodenal perforation. Length of hospitalization for handlebar injuries ranged from 2 to 24 days (mean 6.3 ± 5.81). Outpatient follow-up (between 1 to 8 months) with repeat imaging showed resolving injuries.

Conclusion: Over the past 20 years, we have had successful management of severe intra-abdominal injuries related to bicycle handlebar with no mortality. Since the implementation of state law to mandate helmets in young riders, the incidence of traumatic brain injuries has decreased. Handlebar injuries in children still continue to pose a problem.

INTRODUCTION

Trauma remains the primary cause of morbidity and mortality in the pediatric population. Bicycle-related injuries remain a very common mechanism of trauma in children. Specifically, handlebar injuries in this population have been shown to cause devastating intra-abdominal injuries. Cherniawsky and colleagues sought to characterize the epidemiology of handlebar injuries in children at their institution. In their study, 462 children 17 years of age and younger were found to have a mechanism of injury consistent with bicycle trauma. Abdominal handlebar injuries, making up 9% of these injuries, were the etiology behind 19% of all internal organ injuries, and 45.4% of solid, 87.5% of hollow, 66.6% of vascular or lymphatic, and 100% of pancreatic injuries in their study cohort. Based on their analysis, Handlebars were 10 times more likely to cause severe injury than any other mechanism. Ghosh and colleagues published a traumatic abdominal wall hernia (TAWH) secondary to bicycle handlebar impact to the abdomen. In their literature, TAWH in an adult was present with a concealed small bowel perforation. During operative exploration, a serosal tear in the small bowel was revealed but, upon more focused evaluation of the bowel, a separate 3 mm perforation was identified and was hidden in the small bowel mesentery [2]. Rathore and colleagues published their observations of emergence of these TAWHs in the pediatric handlebar injury population. They surmised that these injuries often occur at the end of the handlebar which often lacks protective padding. This part of the bicycle applies substantial focal blunt force to the abdominal wall which damages the muscle fibers and fascia. They report that such non-penetrating injuries should be suspected, even if clinical signs are minimal. Computed tomography or ultrasonography was utilized to identify these injuries most frequently in their patient population. Management included surgical exploration and repair of the defect. They concluded that post-operative outcomes were good assuming no other significant underlying injury was identified [3]. Lam and
colleagues also describe the delayed presentation of handlebar injuries in children as well as the subsequent affect that the delay in diagnosis can have on post-operative outcomes [4]. Nadler and colleagues divided handlebar injury patients into two groups to study their hospital course and outcomes: those who flipped over the handlebars (n = 160) and those who sustained direct impact from the handlebars (n = 61). They found that children who suffered a direct impact of the handlebars to the abdomen required operative intervention more often and have a longer hospitalization than those who flipped over the handlebars. They recommended that future injury prevention strategies for bicyclists should be targeted at reducing the incidence of direct impact handlebar-related injuries [5].

Because of the specific nature of these injuries, more work is warranted to further characterize mechanisms, presentation, diagnostic workup, non-operative or operative interventions, and post-operative outcomes in the pediatric patient population. The aim of this work was to analyze the impact of handlebar injuries in pediatric trauma patients over the past 20 years at our institution.

METHODS

We performed a single-institution retrospective medical record review of all of the pediatric bicycle accidents ages 15 years old or younger, who required hospitalization for their injuries. Data was collected from 1995 to 2015. Each case was evaluated for mechanism and severity of injuries, physical and radiographic findings, treatment administered length of hospitalization, and patient outcomes. Patients’ injuries were graded based upon an injury severity score (ISS). Majority of patients underwent computed tomography (CT) of chest, abdomen and pelvis as part of our trauma protocol. Demographics and outcome frequencies were calculated to characterize our study cohort. We did not perform any additional statistical analysis. This work was approved by the Institutional Review Board at our facility.

RESULTS

There were a total of 83 pediatric bicycle accidents over the past twenty years, which required hospital admission. Twenty of the 83 patients (24%) sustained direct handlebar injuries. There were 15 males and 5 females: ranging from age of 5 to 15 years old (mean 10.3 ± 2.55). Type of injuries included traumatic hernia, bony fractures, and multiple solid organ injuries: spleen (5), liver (3), kidney (2), pancreas (3), and adrenal (1) (Figure 1-4). The mean injury severity score (ISS) for our patient population was 10.3 ±6.03. Most patients were successfully managed non-operatively with close ICU monitoring. Our data agree with current paradigm, which favors non-operative management for blunt abdominal injuries. Two patients required surgical intervention for traumatic Spigelian hernia and duodenal perforation (Figure 5-7). The duodenal perforation occurred in a 12 years old male who was found to have hemoperitoneum in subhepatic and paracolic gutter on CT scan. After a negative diagnostic laparoscopy, patient persisted to have abdominal pain. He underwent a follow-up upper GI series, which demonstrated contrast leak in the 3rd portion of the duodenum. Patient underwent exploratory laparotomy and graham patch repair for duodenal perforation.

Length of hospitalization for handlebar injuries ranged from 2 to 24 days (mean 6.3 ± 5.81). Length of hospital stay correlated with grade of solid organ injury. Patients with higher grade of solid organ injury required longer periods of laboratory monitoring, strict bed-rest, and hospital stay. Patients with co-existing operative bony fractures also required longer hospitalization due to timing of surgery and post-operative recovery. The overall
length of hospitalization has diminished during the past 20 years due to earlier mobilization of patients and improved diagnostic imaging. These demographic and outcomes data are reported in Table 1. Outpatient follow-up (between 1 to 8 months) with repeat imaging showed resolving injuries and no complications.

**DISCUSSION**

Bicycle injuries in the pediatric population have been frequently reported. Much of the injury prevention strategies are centered on helmet use and prevention of head injuries. While this remains a salient effort to prevent morbidity and mortality in childhood bicycle trauma, the potential for serious and life-threatening intra-abdominal trauma should not be underestimated. Karaman and colleagues underscore the importance of this in their retrospective review. They state that “although bicycle handlebar injuries occur at relatively low speeds, the transfer of energy from the end of the handlebar, with a small cross-sectional area, to a small field leads to intra-abdominal injuries that are more severe than predicted. Thus, bicycle handlebar injuries should be considered as a serious intra-abdominal injury until proven otherwise” [6]. The physics of handlebar injuries after direct impact to the abdomen are such that tiny injuries to the solid or hollow viscera and vasculature can evolve into life-threatening situations [7-9]. Vascular injuries, a less-common presentation after such handlebar injuries, must also be considered in a patient with hemodynamic instability or abnormalities in extremity perfusion or pulse exam. Singla and colleagues published a case of delayed external iliac artery occlusion in a young male following blunt abdominal injury. He was successfully treated with thromboendarterectomy and saphenous vein patch repair [10].

Figure 4 Grade 4 Renal laceration.

Figure 5 Duodenal perforation repair.

Figure 6 Traumatic abdominal wall hernia with underlying small bowel contusion.

Figure 7 Traumatic abdominal wall hernia with underlying small bowel contusion.

Table 1: Demographic and outcomes data.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>N (%) or Median (IQR)</th>
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<tbody>
<tr>
<td>Age (years)</td>
<td>Mean 10.3 ± 2.55</td>
</tr>
<tr>
<td>Male: Female</td>
<td>0.75</td>
</tr>
<tr>
<td>Type of Injuries</td>
<td></td>
</tr>
<tr>
<td>Spleen</td>
<td>5</td>
</tr>
<tr>
<td>Liver</td>
<td>3</td>
</tr>
<tr>
<td>Pancreas</td>
<td>3</td>
</tr>
<tr>
<td>Renal</td>
<td>2</td>
</tr>
<tr>
<td>Adrenal</td>
<td>1</td>
</tr>
<tr>
<td>Rate of Operative Intervention</td>
<td>0.1</td>
</tr>
<tr>
<td>Range of Length of Hospitalization</td>
<td>2 to 24 days (Mean 6.3 ± 5.81)</td>
</tr>
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</table>
Complete transection of the external iliac artery and laceration of the external iliac vein without presence of an orthopedic injury. They reported that this patient deteriorated rapidly but was rapidly managed successfully with aggressive resuscitation and revascularization [11]. The abdomen and pelvis contain many vital structures within such a compact compartment. The overall conclusion of many of the existing studies do agree that severe hollow or solid organ injury should be suspected in a handlebar injury until proven otherwise with close observation for changes in physical and abdominal exam, reassuring imaging and lab values, and surgical exploration as indicated. Over the past decades, pediatric trauma has successfully evolved in non-operative management of severe solid organ injuries. Close observation in ICU setting is now the standard of care for high-grade solid organ injuries.

This specific type of injury portends a significant financial cost; especially if diagnosis is delayed and complications hinder or prevent a desirable outcome. Winston and colleagues utilized cost estimates from extrapolated hospital discharge data from 19 states in the United States. The results were significant. The estimated national costs of handlebar-related abdominal and pelvic organ injuries were $9.6 million in total hospital charges, $10.0 million in lifetime medical costs, $11.5 million in lifetime productivity losses, and $503.9 million in lifetime monetized quality-adjusted life-years [12].

These potential life-threatening complications and estimated costs highlight the need for injury prevention initiatives for this patient population. Campaigns which have been successful in promoting helmet use in children could also be tailored to address the potential for handlebar injury. Parental and childhood educational programs could prevent some of these injuries, improve outcomes, and offset the substantial financial burden associated with this type of trauma. In addition, requirements for safer handlebar designs, possibly with greater padding, could provide another protective mechanism for these children.

Our retrospective medical records review has similar limitations proposed by other studies with the same design. Exposure and outcomes assessment cannot be controlled for directly. Errors in coding and record keeping may exist. Our sample size is small; however this is due to our focus on capturing a specific subset of bicycle handlebar injuries. Additionally, our study did not look at costs specifically; however, the management of solid organ and hollow organ injuries in our patient population likely mirrors that of some of the studies cited in this work.

CONCLUSION

Over the past 20 years, we have had successful management of severe intra-abdominal injuries related to bicycle handlebar with no mortalities. Since the implementation of state law to mandate helmets in younger riders, the morbidity of traumatic brain injuries has decreased. However, the incidence of handlebar injuries in children still continues to pose a problem. Further work into injury prevention strategies is indicated.

What do we know?

- Handlebar injuries are often seen in the pediatric population and have the potential to cause severe intra-abdominal injuries.
- Injuries can include occult bowel perforation and solid organ injury.
- What does this add to the literature?
- This was a 20-year experience with handlebar injuries and their subsequent patient outcomes at a Level One pediatric trauma center.
- We report successful management of severe intra-abdominal injuries related to bicycle handlebar with no mortality.

GRANT SUPPORT

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REFERENCES