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CLINICAL CASE

Blunt abdominal trauma due to handlebar injury

Trauma abdominal contuso por golpe con manubrio de bicicleta

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What do we know about the subject matter of this study?

Injuries from bicycle handlebar accidents are a common cause of abdominal trauma in children. In Chile, there are no articles on this subject.

What does this study contribute to what is already known?

In this paper, we raise concerns about the different mechanisms of injury caused by bicycle handlebars, emphasizing the conservative management of blunt abdominal trauma in pediatric patients.

Abstract

Introduction: Bicycle accidents are a frequent cause of blunt abdominal trauma in children. In Chile, there are no scientific articles about such accidents, their presentation and management. **Objective:** The aim of this study is to describe three cases of blunt abdominal trauma due to handlebar injury in children, in order to illustrate the different kinds of lesions, their presentation, and management. **Clinical Cases:** 1) 11-year-old boy presented to Emergency Department (ED) after falling on a bicycle handlebar, hitting his epigastric region. A CT scan showed signs of duodenal perforation. A laparotomy was performed and the duodenal perforation repaired. 2) 14-year-old boy seen at ED after a bicycle accident in which the handlebar hit him in the abdomen area. A CT scan showed a splenic injury with multiple lacerations and active bleeding that was treated with angioembolization. After 6 weeks of follow-up, he presented resolution of the lesion and viability of the spleen. 3) 9-year-old boy admitted due to a hit with the bicycle handlebar on the abdomen area. A CT scan showed a hepatic injury that was managed with non-surgical procedures, achieving resolution of the lesion after 8 weeks of follow-up. **Conclusion:** Blunt abdominal trauma caused by handlebar can be potentially serious in pediatric patients, since it may affect solid and hollow abdominal viscera. Non-surgical management is becoming more used for stable patients, achieving high success rates. Unstable patients or those with suspicion of hollow viscera perforation will require surgery as first approach.

Keywords:
Blunt abdominal trauma;
bicycle;
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Introduction

Trauma is a major cause of morbidity and mortality in pediatrics. In Chile, during 2017, 40.1% of deaths between the ages of 1 and 19 were secondary to trauma[1]. Bicycle accidents account for a significant proportion of all trauma in children[2-4]. According to our country's records, during 2016, of all those injured due to traffic accidents involving cyclists, which were 3,326, 14% were children under 18 years of age (489 injured)[5]. The prevention of serious injuries associated with this type of accident has focused on the use of helmets, thus reducing the incidence of brain injury[2,4]. However, injuries to intra-abdominal organs are still frequent[6].

Bicycle accidents can cause damage by two mechanisms, fall from it, associated with head trauma, or a blow with one of its parts, most commonly the handlebars[7]. When faced with a direct hit to the abdominal area, a pediatric patient is at higher risk of suffering internal organ injuries compared with an adult patient[2]. In a child's body, forces are more easily transferred through the abdominal wall and there is a greater relative surface area of solid organs such as the spleen and liver[2].

There are diverse types of injuries caused by these accidents. In the abdominal region, the most frequently affected[7,8], injuries of hollow viscera and solid organs are described. Hollow viscus injuries may include perforation or hematoma along the gastrointestinal tract and its mesentery. Among the solid organ lesions, the most frequent are the hepatic, splenic, pancreatic, and renal ones[7]. Their magnitude is measured according to the scale of the American Association for the Surgery of Trauma (AAST), which is based on an anatomical description and goes from I (the least serious lesions) to V (the most serious ones)[9].

Traditionally, the finding of free fluid or solid organ injury has been managed with emergency surgery[8]. However, the high associated morbidity has favored conservative management, which has proven to have better short- and long-term results[6]. The use of imaging, such as CT scan, has allowed identifying the location of the lesions, and help to determine their severity, providing elements to define the best therapeutic alternative.

There are no scientific publications in our country that address this type of accident and presentation in the pediatric population, despite its high frequency and potential seriousness. The objective of this work is to describe three clinical cases of blunt abdominal trauma in children caused by bicycle handlebars and to describe different types of observable injuries, with their forms of presentation and respective management.

Clinical Cases

The patients presented below were treated following the protocols of the "Advanced Trauma Life Support" (ATLS) program of the American College of Surgeons in addition to the relevant positive findings.

Case 1

Healthy 11-year-old male patient was admitted 90 minutes after falling from a bike where the handlebars hit his epigastric region. He presented with tachycardia (104 bpm), high blood pressure (132/90), and 15 points in the Glasgow Coma Scale (GCS). On physical examination, he was in poor general condition, slightly dehydrated, well-perfused, with severe abdominal pain and muscle rigidity to palpation, and an erosive lesion in the epigastrium (Figure 1).

An abdominal and pelvic CT scan with contrast was performed, which showed pneumoretroperitoneum (Figure 2). Given the suspicion of duodenal injury, an exploratory laparotomy was performed, which detected a 2-cm perforation between the second and third portion of the duodenum, on the lateral side (Figure 3). A duodenorraphy was performed transversally in two planes. A transanastomotic nasojejunal tube, nasogastric tube, and drainage were placed. There were no other lesions identified.

The patient was admitted to the Pediatric Critical Care Unit (PCCU) where he remained for 24 hours. On the second postoperative day, he was transferred to the ward. On the fifth day, the nasogastric tube and drainage were withdrawn, and enteral feeding was progressively restarted. The patient remained in good condition and was discharged on the ninth postoperative day. He attended checkup visits 10 days, 2 months, and 11 months after discharge, showing good evolution.

Case 2

Healthy 14-year-old male patient went to the emergency room 60 minutes after falling from his bike hitting the left thoracoabdominal region with the handlebars. He presented with tachycardia (128 bpm), normal BP, 15 points in the GCS, and was immobilized with a cervical collar. On physical examination, he was pale, well-hydrated, and perfused. He presented superficial abrasion on the right shoulder and the left hypochondrium and thigh. He reported slight pain on cervical palpation. Diffuse abdominal tenderness, which was increased in the left hypochondrium, associated with muscle rigidity and Blumberg sign.

In the ER, initial resuscitation was started with the administration of fluid bolus volume, which normalized the heart rate (83 bpm), and intravenous analgesia was administered. CT scan of the cervical spine, thorax, abdomen, and pelvis was performed. Spinal injury

was ruled out and coronal imaging showed splenic rupture with multiple lacerations and signs suggesting active arterial bleeding, without hilar liver laceration; associated to laceration of the pancreas tail with presence of small anterior and posterior peripancreatic fluid collections, perisplenic free fluid in the pelvis and ascites (Figure 4). The splenic lesion was classified as IV-A AAST[9]. Due to the presence of active bleeding, splenic embolization was performed by angiography without incidents (Figure 5).

After an initial drop of hematocrit level by seven points, which required red blood cell transfusion, he remained stable, monitored for three days in the UPC. Before his transfer to the ward, a new abdominal CT scan showed resolution of the pancreatic laceration with a decrease in the quantity of the collections, viability of the spleen, and reabsorption of hemoperitoneum. He restarted feeding without incident and complete bed rest for a week. He progressively restarted walking and was discharged 48 hours later, in good condition, after an ultrasound control that showed stability of the injuries.

Clinical checkup and abdominal ultrasound two and six weeks after the accident showed a spleen of normal size and irrigation and healthy pancreas without the presence of collections or pseudocysts. Due to this, the patient's age, and clinical stability, further CT controls were ruled out.

Figure 1. A skin lesion (tattoo) is observed in the epigastrium from a blow with a bicycle handlebar (arrow). Arrow: epigastric tattoo.

Case 3

Healthy 9-year-old male patient who visits the ER after 30 minutes of bicycle accident with impact of the handlebars on right hypochondrium. He was admitted stable, normal heart rate, HBP (120/73), and

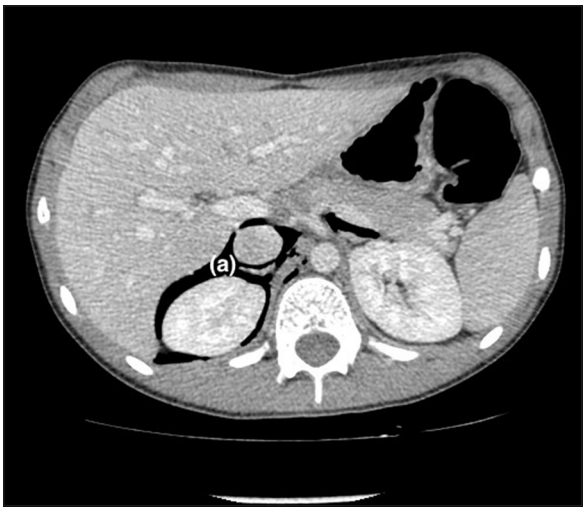

Figure 2. Computed tomography of the abdomen and pelvis with intravenous contrast. Axial plane. The imaging shows extensive pneumoretroperitoneum (a) and blood accumulated in the right parietocolic recess (not visualized in this image), findings that are suggestive of a duodenal perforation. (a) pneumoretroperitoneum.

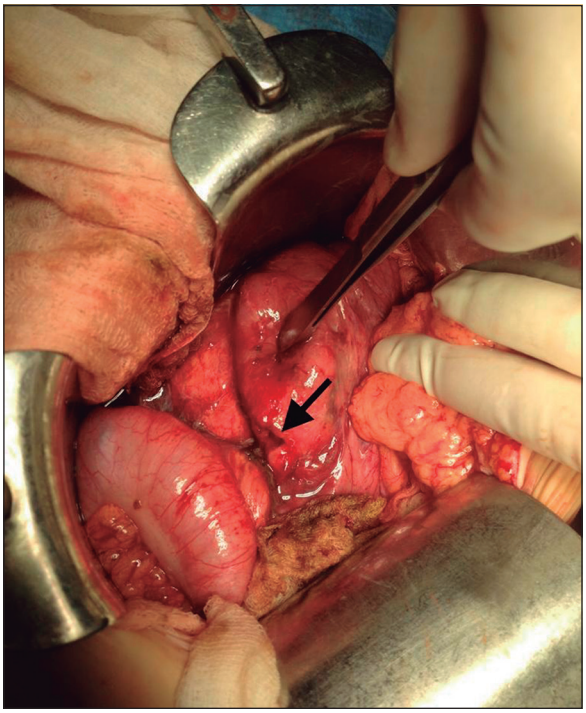

Figure 3. Exploratory laparotomy. A defect is observed in the lateral wall of the duodenum, between the second and third portion (arrow). Arrow: duodenal perforation.

with 15 points in the GCS. On physical examination, he was pale, with intense pain and abrasion in right hypochondrium, without signs of peritoneal irritation.

An abdominal and pelvic CT scan showed a 40-mm long laceration in segment VI of the liver, associated with mild hemoperitoneum and parietal bowel thickening at the hepatic angle, and was classified as III AAST liver injury[9] (Figure 6). The laboratory tests showed increased transaminases (SGOT 293 U/L, SGPT 175 U/L). Fluid Bolus volume was administered and pain was managed with a patient-controlled analgesia pump, and conservative management was decided. He was admitted to the pediatric CPU for monitoring and complete bed rest until the abdominal pain ceased. Oral feeding was restarted progressively after 24 hours. On the third day, an abdominal CT scan was performed, which showed stability of the injury. He evolved favorably and was discharged on the sixth day. The ultrasound control at 2, 8, and 12 weeks after discharge, reported resolution of the liver lesion.

Discussion

Bicycle accidents are a common cause of trauma in pediatrics[2-4]. However, in our country, no works are describing the frequency and characteristics of them. Those lesions caused by getting hit with the handlebars are a special subgroup since they have more risk of causing injuries to intra-abdominal organs. On the other hand, those lesions caused by a fall from the bike, usually cause injuries to the extremities, head, neck, and nervous system[7]. A retrospective series of 385 cases of pediatric patients who suffered bicycle accidents published in 2019 is the study that gathers the largest number of patients[7]. The 27.8% of the accidents were due to a hit with the handlebars, of these, 34.6% suffered some injury of solid organs and 9.3% of hollow viscera. Of the total of this group, 41.1% required some kind of intervention.

This article describes the cases of three patients exposed to the same mechanism of trauma. The first one with duodenal perforation that required surgical management, the second one with a splenic laceration and active bleeding managed with selective angioembolization, and the third one with a hepatic laceration where we chose the conservative management. All three cases achieved successful recovery, without requiring reintervention, and with a follow-up showing favorable evolution. All patients presented skin lesions caused by the bicycle handlebars, which were spatially related

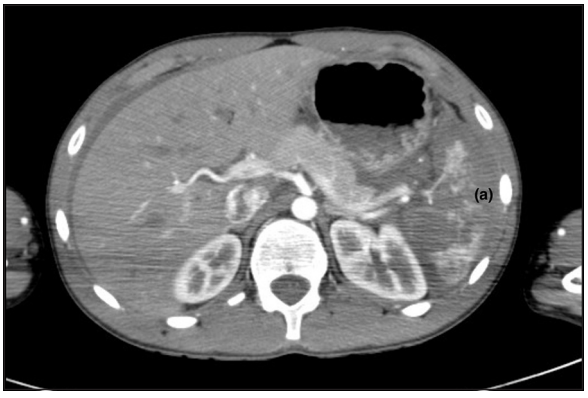

Figure 4. Computed tomography of the abdomen and pelvis with intravenous contrast. Axial plane. The image shows the impregnation "in patches" of the contrast medium in the spleen (a), a finding compatible with splenic rupture. (a) Spleen.

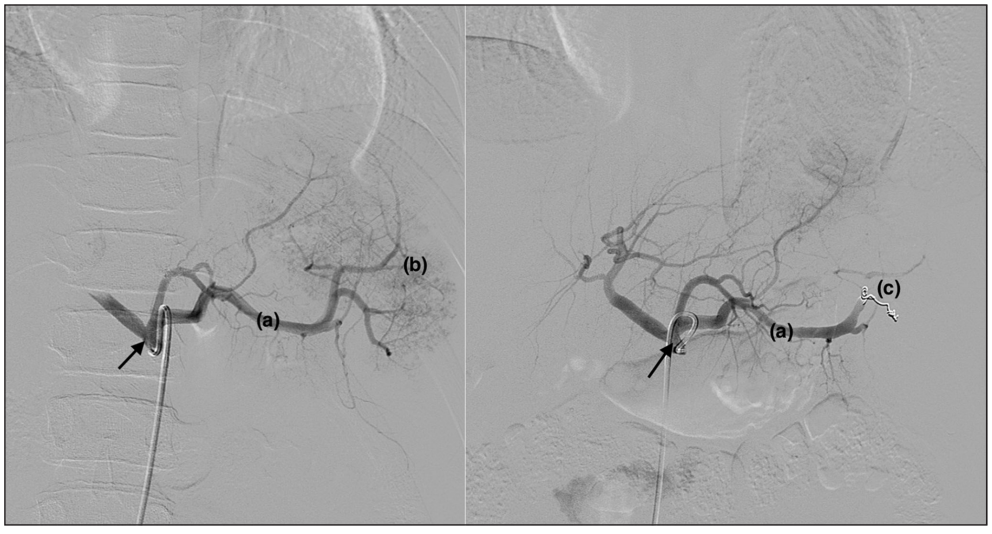

Figure 5. Angiography. The image on the left is the first control: Injection in the celiac trunk (arrow) and splenic artery (a) showing sinusoidal impregnation of the spleen with alteration of the vascularization of the middle and lower third (b) consistent with splenic rupture, without evidence of focal arterial bleeding. The image on the right corresponds to the post-embolization angiography: proximal embolization in the splenic hilum using microcoils (c), preserving irrigation of the upper third of the spleen. Arrow: celiac trunk, (a): splenic artery, (b): spleen, (c) microcoils.

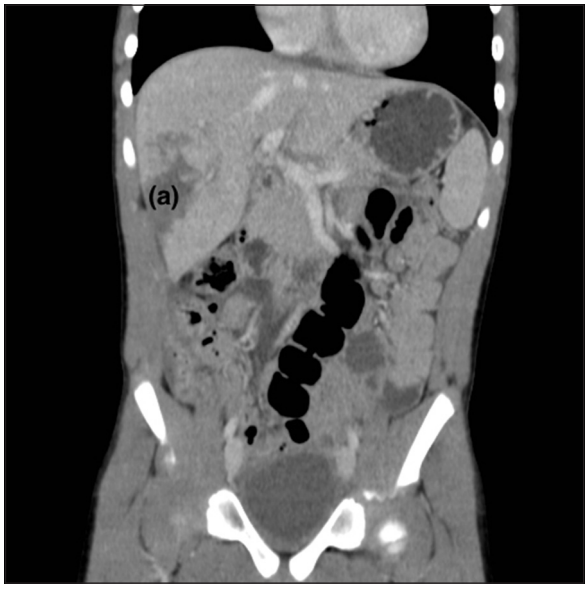

Figure 6. Computed tomography of the abdomen and pelvis with intravenous contrast. Coronal reconstruction. The image shows a laceration of segment VI of the liver (a), more than 3 cm deep. (a) liver laceration.

to the internal lesions. Thus, most of the time there is a link between the intra-abdominal organ lesions and the location of the handlebar mark in the abdominal area (Figure 1).

The initial approach to any child with this type of trauma should follow the protocols of the ATLS program, known as the "A-B-C" of trauma, which prioritizes the treatment of life-threatening injuries in the short term. Once the primary and secondary evaluation has been completed, the test of choice in children with abdominal trauma is a CT scan with contrast, which will allow the identification of the internal injuries, their classification, and definition of their management[10].

Diagnosing hollow viscus injuries can be difficult and even late[3,8,13,14]. About 50% of patients present typical signs of peritonitis on physical examination, such as muscle rigidity or Blumberg sign[13,15].

The finding of pneumoperitoneum or pneumoretroperitoneum, as in Case 1, is present in only 59% of the patients. In the absence of this finding, other important signs to look for in the CT scan that suggest intestinal perforation are parietal bowel thickening, bowel hematoma, and the presence of free intra-abdominal fluid not explained by any other cause[26]. In these cases, the management should be surgical and the gold standard therapeutic is exploratory laparotomy[13]. Surgery has a morbidity of 20%, mortality up to 5%, and risk of long-term intestinal obstruction of 3%[17]. In the case of duodenal perforation, it is recommended to place a nasojejunal tube to allow early enteral feeding, as well as a nasogastric tube for decompression, which allows decreasing the interval at the beginning of the oral regimen[13]. In the patient of Case 1, it was possible to start the oral regimen progressively on the fifth day after the accident. In this patient, the epigastric contusion could have affected any of the anatomical structures inside. In the case of the duodenum, injuries tend to occur in the retroperitoneal portions of this organ, which are fixed and, therefore, compressed against the elements of the posterior abdominal wall, such as the spine.

The specific management of pediatric patients with solid organ contusions, such as liver or spleen, varies according to the hemodynamic condition[11,18]. In stable patients, exclusive medical treatment is indicated, achieving success rates close to 90%[10,19]. Failure of conservative management generally occurs within the first 12 hours and factors associated with increased risk have been identified such as hypovolemic shock, active hemorrhage, peritonitis, perforated hollow viscus, increased severity of the injury, and injury to multiple organs[10,12,18].

If the patient is hemodynamically unstable or an unfavorable evolution is anticipated, active management is necessary[3,4], which will depend on the characteristics of the lesion. The traditional approach has been exploratory laparotomy[8]. The usefulness of laparoscopy has been proposed in specific cases[20]. Splenectomy has been the surgical treatment of choice in splenic lesions[21]. However, it is recognized that pediatric patients who have undergone splenectomy due to trauma are at higher risk of long-term infectious complications, thus, organ preservation is an especially important objective in these patients[18]. Therefore, in the patient of Case 2, who presented active bleeding, it was decided to perform selective angioembolization in order to avoid splenectomy. Selective angioembolization has been described as a safe and effective option in adult patients with solid organ injury that has been extrapolated to pediatric patients[19]. It is proposed as an alternative to reduce the failure rate of medical management, and, therefore, avoiding surgical management and splenectomy with its subsequent complications[21]. Currently, there are no prospective studies that demonstrate the benefit of angioembolization in the pediatric population[19]. This approach should be considered in patients who do not respond to initial medical management and in those who are actively bleeding[10,18,22,23].

Liver function tests are focused on the presence of liver injury in patients with deficient physical examination or even when a liver injury is not suspected since an increase in transaminases above normal values is a predictor of liver injury[3,15]. The diagnos-

tic confirmation of liver trauma, its classification, and management, should be through a CT scan with contrast[10]. In the patient of Case 3, at admission, increased transaminase levels were found, which were consistent with the liver lesion identified in the CT scan. On the third day of hospitalization, the hepatic profile was repeated, evidencing a significant decrease in transaminases, consistent with the stability shown in the follow-up CT scan, which ruled out the presence of complications.

In pediatric patients with high-grade liver lesions, it is necessary to rule out the presence of a biliary tree lesion. An alternative is to perform liver scintigraphy, a non-invasive diagnostic method that does not require anesthesia, with high sensitivity and specificity[24-26]. In patients with a high suspicion of a biliary leak or that has been confirmed through biliary scintigraphy, the approach with endoscopic retrograde cholangiopancreatography is proposed as a safe and effective therapeutic option, with a low rate of associated complications, which contributes to avoid surgical management. Its role is both diagnostic and therapeutic as it is complemented by the placement of a stent or sphincterotomy[24-26]. In the patient of case 3, there was no suspicion of a bile duct lesion, since the laceration was far from the biliary tree. Therefore, the described studies were not considered and follow-up with CT scan was carried out only, ruling out the increase of free fluid that would force active management.

In this work, we described three cases of patients who presented blunt abdominal trauma due to a hit with a bicycle handlebar. Although they share the mechanism, they presented different injuries and so was their management. The evolution in the short- and long-term was favorable in all of them.

In conclusion, blunt abdominal trauma due to hit with bicycle handlebars, although rare, can be potentially serious in pediatric populations, affecting solid organs and hollow viscera. Non-surgical management is increasingly used, achieving high success rates in stable patients. Unstable patients, or those in whom hollow viscera perforation is suspected, will require surgery as a first approach.

Ethical Responsibilities

Human Beings and animals protection: Disclosure the authors state that the procedures were followed according to the Declaration of Helsinki and the World Medical Association regarding human experimentation developed for the medical community.

Data confidentiality: The authors state that they have followed the protocols of their Center and Local regulations on the publication of patient data.

Rights to privacy and informed consent: The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the correspondence author.

Conflicts of Interest

Authors declare no conflict of interest regarding the present study.

Financial Disclosure

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