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## Handlebar injury in children: Are we ignoring the signs?

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## ABSTRACT

The diagnosis of blunt intestinal injury in children is difficult and often delayed. We describe two cases of delayed diagnosis of intestinal injury following handlebar injury with abdominal wall tattooing. We review the literature to try and determine the usefulness of handlebar tattooing characteristics as a clinical sign for underlying small bowel injury in order to reduce delayed treatment. We propose a management algorithm for patients with handlebar tattooing.

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In developed nations trauma is one of the leading causes of mortality in children and even though head trauma is responsible for most of the cases that result in death, abdominal trauma is not uncommon. The surgical indication for these patients can be difficult and severe injuries to solid organs can occur with minimal skin bruising and symptoms. We report two selected cases of severe handlebar injuries with delayed treatment and propose an algorithm for low intensity concentrated impact management.

## 1. Case reports

## 1.1. Case 1

A 9 year old girl sustained a bicycle handlebar injury, arriving at our center 2 h after the incident with slight skin paleness and left flank abdominal tenderness with handlebar tattooing. Initial ultrasound was normal except for a small amount of free abdominal cavity liquid. Laboratory tests were normal. A CT scan was performed that reported no hollow or solid organ injury and a doubtful image of a small 2 mm air bubble in the right flank (Fig. 1). The patient's stable condition and tests allowed for conservative management. After 48 h, the patient remained hemodynamically stable, but because of the persistent tenderness of the left flank a surgical

exploration was undertaken with a laparoscopic approach. A 2 cm perforation of the small bowel was found covered by the greater omentum. The bowel was repaired and the patient was discharged 7 days later.

## 1.2. Case 2

An 11 year old girl fell over her bicycles handlebar on her left flank; she arrived at a regional hospital where an initial ultrasound didn't reveal any abdominal lesions. Even though she had a handlebar tattoo (Fig. 2) she was discharged hours later only to return with abdominal pain. An abdominal x ray was normal and the patient was hospitalized for observation. The abdominal tenderness persisted and on her 4th day a CT scan and follow up x ray revealed signs of pneumoperitoneum. The patient was then transferred to our center where a perforation of the small intestine 10 cm from Treitz angle was identified and primarily repaired. The patient was discharged definitely on her 5th post operative day.

## 2. Discussion

## 2.1. Incidence and clinical manifestations

Severe abdominal injuries related to bicycles occur, in over 80% of cases according to some studies, under unremarkable circumstances consisting in falling from a low altitude with consequent stabbing with the blunt handlebar [1,2]. In the United States it is estimated that severe abdominal handlebar related injuries not

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Fig. 1. CT with 2 mm bubble on the left flank.

involving automobiles has an incidence of approximately 1.15 per 100,000 patients aged 19 years and younger. This same study estimated hospital costs to be higher than 10 million dollars [1]. Severe injury is more frequent in male patients, the mean age ranges according to different studies usually being between 10 and 14 years old, and bicycle accidents are the leading cause of abdominal injury in children [1–4]. A direct impact of the handlebar in the abdomen

is more likely to cause severe internal organ damage than just falling off the bicycle [5,6]. Some studies even identify the BMX type bicycles with unpadding handlebars as more dangerous [7]. Only 31% of adolescents aged 11 to 19 wear helmets [8]. Out of the total blunt abdominal traumas with small bowel perforations, 14–20% are bicycle related, and about half without peritonism at presentation or pneumoperitoneum in the initial plain x-ray (54–85%) [9]. The most frequent injuries are abdominal injuries to the spleen, liver and the pancreas; these were usually treated with conservative management. A more rare type of injury is the bucket-handle tear of the mesocolon [10]. Another very specific type of injury is the abdominal wall hernia, as seen in lap-belt injuries as well, and is due to the thinner abdominal wall and less developed abdominal musculature [11]. Even though the abdomen is clearly the most frequent site of injury other sites can suffer severe injuries including the face, chest and thighs [12]. There have been more uncommon injuries to vascular structures such as the femoral vein [13].

## 2.2. Diagnosis and management

Traditionally, abdominal trauma with radiologic findings of solid organ damage or free abdominal liquid was treated with emergency surgical procedures. In children, this same reaction to abdominal trauma was used. The poor outcomes and high morbidity of this strategy led to a more conservative management of these types of injuries leading to better results. When it comes to hollow viscous injuries the importance of short delays in diagnosis and treatment is difficult to determine. Some studies suggest that a delay as short as 8 h can increase septic complications, while others find no association to higher morbidity or mortality [14,15]. Patients that while in observation manifest tachycardia, fever of decreased urine output with persistent or increased abdominal pain may indicate a concealed small bowel injury [15]. The average delay from the moment of injury to treatment was 18 h up to 23 h in some studies [5,16]. Therefore, observation should include close assessment of vital signs and urine output as well as serial physical examination and/or ultrasounds at the emergency department [17].

In a series of conscious patients with blunt abdominal injury by different mechanisms including handlebar injury, initial CT scan proved to be negative, and a serial physical examination was more reliable to identify peritonitis [18]. It is also important to note that several studies show free intra-abdominal fluid can be characteristic of intestinal injury but it is not an indication for surgical exploration [14]. CT is the best radiologic test for trauma able to identify multiple intra-abdominal abnormalities [19]. Focused abdominal sonography for trauma (FAST) is an important tool in adult trauma centers, unfortunately it has been proven to have many false negatives in children, it requires experience and specialized training, and rarely directs management of the patient [20]. Contrast enhanced ultrasound can be a helpful tool in identifying injury to solid organs, but it is difficult to use in an emergency setting and isn't better than CT for bowel perforation [21]. The negative long term effects of ionizing radiation in children have been a reason of concern, nevertheless there is agreement that a well indicated CT outweighs the potential dangers [22]. This risk/benefit balance was addressed by Holmes by creating a risk stratification based of clinical findings that helps identify patients with very low risk of intra-abdominal injury and reduce the number of unnecessary CT scans, patients with evidence of abdominal wall trauma or seat belt sign were the most likely to have an intra-abdominal injury [23]. As mentioned before, initial evaluation with ultrasound is acceptable for stable patients and non-remarkable findings in the physical examination. A CT is to be considered in cases of abdominal bruising, which is associated with



Fig. 2. Handlebar tattoo on upper left flank.

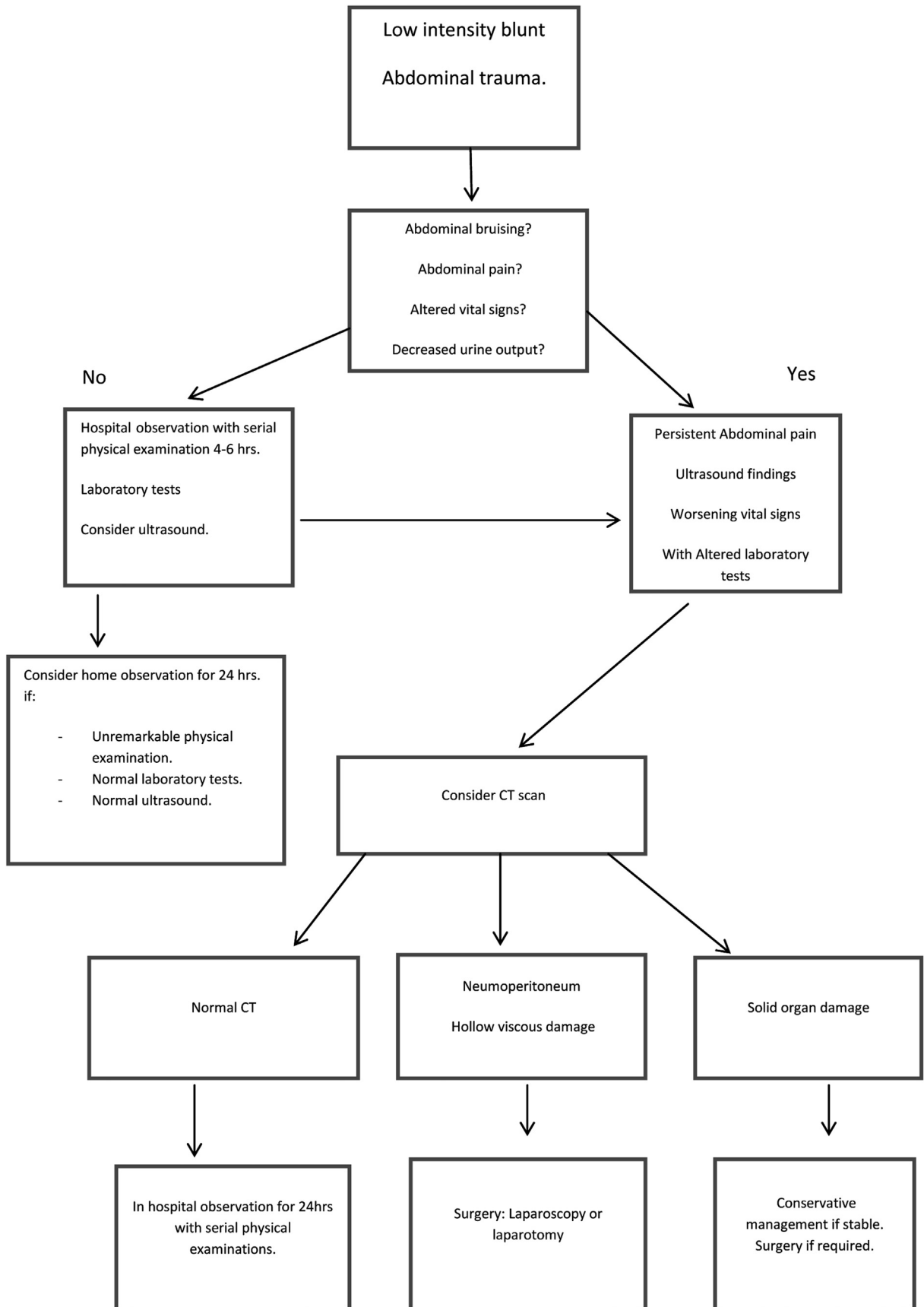


Fig. 3. Management algorithm, with handlebar tattooing (abdominal bruising) as part of the initial patient considerations.

intra-abdominal injury especially if accompanied by persistent abdominal pain or worsening vital signs [23,24].

In the literature there are no studies in which handlebar tattooing is accurately described or characterized, there is no description of the relationships between tattoo size or equimotic halo diameter or location with trauma severity. Treatment algorithms available are based on standardized care guidelines that are designed for high velocity/intensity trauma.

### 2.3. Morbidity and prognosis

Stable patients that require no surgical treatment often have uneventful follow ups. There is no information of long term organ dysfunction of the spleen or liver which are the most frequently affected. There is a case report of the development of diabetes mellitus 3 years after blunt abdominal trauma in a child [25]. Several studies have compared different trauma scores to determine short term prognosis, a recent study determined that the most reliable trauma scores for children are the abbreviated trauma score (AIS) and the injury severity score (ISS) [26]. These scores don't discriminate between the intensity of impact or the mechanism. We believe there is the need for a low intensity blunt trauma specific algorithm, suitable for handlebar injuries. Several groups have published their centers algorithms [6], the expansion in the use of such algorithms we believe is key to a better management of our patients. We propose our own management algorithm for low intensity blunt abdominal trauma (Fig. 3).

### 3. Conclusion

Handlebar injuries are frequently underestimated and injuries to the small bowel can be overlooked. Times to definitive management have a tendency to be over 18 h. Serial physical examination, laboratory findings and vital signs including urinary output are more sensitive than radiologic studies in the first hours. A CT is the most reliable radiologic study, which should be indicated if the aforementioned physical parameters are altered. Most solid organ injuries can safely be managed conservatively. Low impact blunt trauma specific algorithms are an important part of adequate management for hollow viscous injury.

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