Clinical Case Report

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Analysis of the use of upright abdominal radiography for evaluating intestinal perforations in handlebar traumas

Three case reports

Feride Mehmetoğlu, MD*

Abstract

Rationale: Intestinal perforations due to blunt abdominal handlebar trauma are difficult to diagnose. This report presents a retrospective analysis of 3 patients with intestinal perforations due to abdominal bicycle handlebar trauma who were diagnosed via upright abdominal radiography.

Patients concerns: All the patients lost their balance while riding a bicycle for leisure and had fallen on the handlebar tip. The patients were initially misdiagnosed at different-level health centers despite various radiologic investigations performed.

Diagnosis: The patients' intestinal perforations were diagnosed via plain upright abdominal X-ray radiography (UAXR) in our institution.

Interventions and outcomes: The children underwent exploratory laparotomy due to intestinal perforations. All the perforations were repaired either with primary closure or bowel resection and anastomosis with successful outcomes.

Lessons: Pneumoperitoneum due to intestinal perforation can be diagnosed via UAXR with appropriate patient positioning and timing. This case series shows that to accurately diagnose intestinal perforations, upright plain X-ray should be routinely performed, carefully evaluated, and repeated in patients with enduring abdominal complaints.

Abbreviations: CT = computed tomography, CXR = chest X-ray radiography, UAXR = upright abdominal X-ray radiography, US = ultrasonography.

Keywords: blunt abdominal trauma, handlebar trauma, pneumoperitoneum, upright abdominal X-ray

1. Introduction

Bicycle accidents are quite common in children, and they are often ignored due to their frequency and because most of them are unremarkable. However, morbidity and mortality due to blunt handlebar trauma to the abdomen is not unusual.[1] The severity of pediatric handlebar traumas is often underestimated by parents and witnesses, and the underlying trauma may not be detected by healthcare professionals during the initial patient assessment.[2]

Intestinal perforation is one of the serious complications of handlebar abdominal trauma.[3] Several studies have emphasized hidden, delayed, or ignored complaints to describe difficulties in diagnosing handlebar intestinal perforation.[3,4,5,6,7,8] Radiological examination is important for the diagnosis of blunt intestinal perforation; however, the utility of upright abdominal X-ray radiography (UAXR) is underestimated in these traumas, and patients are typically evaluated with more advanced and costly imaging modalities, such as ultrasound (US) and computed tomography (CT).[2,3,6,9] However, traditional radiography of the abdomen remains a valuable diagnostic modality for blunt intestinal perforation.[10,11] This report aimed to demonstrate that upright abdominal radiography remains important in diagnosing handlebar abdominal trauma. Toward this goal, 3 pediatric cases of intestinal perforation related to blunt bicycle handlebar trauma that were diagnosed accurately via UAXR were presented. Written and verbal informed consent to publish was obtained from the patients' legal guardians.

2. Case presentation

2.1. Case 1

An 8-year-old boy was admitted to the emergency service of a secondary public hospital with moderate abdominal pain caused by flipping over the handlebar of his bicycle after hitting a curb when he lost his balance while peddling with 1 hand. Blood and urine analysis, UAXR, and abdominal US were performed. The

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Department of Pediatric Surgery, Dortcelik Children's Hospital, Bursa, Turkey.

** Correspondence: Feride Mehmetoğlu, Department of Pediatric Surgery, Dortcelik Children's Hospital, Bursa 16140, Turkey (e-mail: mferide@yahoo.com).*

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imaging was conducted 4 hours after the accident and did not reveal any pathological anomalies. The patient was discharged several hours later to his home with follow-up instructions. At home, he experienced an increase in severe, colicky abdominal pain, and vomiting commenced. He was admitted to our hospital as a second health center 18 hours after the trauma. The physical examination revealed abdominal tenderness and a handlebar imprint on the abdomen, and UAXR revealed intraperitoneal free air under both sides of the diaphragm. An approximately 2-cm distal ileal perforation was found on exploratory laparotomy. The defect was resected, and the ileal ends were anastomosed. He recovered uneventfully and was discharged 7 days after the surgery.

2.2. Case 2

A 13-year-old boy was admitted to a tertiary hospital 2 hours after a bicycle accident with complaint of moderate pain in the chest, abdomen, and extremities and only 1 episode of nonbilious vomiting. A circular imprint of the handlebar was seen on the abdomen. He reported that while adjusting his earphones, he fell off his bicycle, and the end of the handlebar hit his abdomen. Supine CXR, UAXR, abdominal and pelvic CT, and blood tests and urinalysis were performed. The only pathologic result was microscopic hematuria. He was transferred 9 hours after the accident from this hospital to our hospital for pediatric surgery observation with all the analysis results. A reinterpretation of the UAXR obtained 4 hours after the accident revealed pneumoperitoneum under the bilateral hemidiaphragm, which had not been noticed previously (Fig. 1A). UAXR was repeated, and pneumoperitoneum was confirmed; air-fluid levels were also detected (Fig. 1B). During the exploratory laparotomy, an approximately 2-cm perforation on the antimesenteric aspect of the jejunum was detected, and the perforation was debrided and primarily repaired. The postoperative course was uneventful, and the patient was discharged on the sixth postoperative day.

2.3. Case 3

A 16-year-old male presented to the emergency department of the local primary hospital with abdominal pain and a bruised bulge on the left lower abdominal quadrant immediately after a bicycle accident. He was examined by an emergency physician, and a supine chest and abdominal radiography were performed. He was hemodynamically stable and had abdominal tenderness but no signs of peritoneal irritation. No serious pathologies were revealed, and a dressing was applied to the wall hernia. He was discharged to home with follow-up instructions and next-day review. After 3 hours, he began vomiting, and the abdominal pain slowly increased in severity. Approximately 9 hours after the accident, he returned to the same hospital, and an on-call general surgeon examined the patient. The patient was in diffuse abdominal pain but with stable vital signs except for tachycardia. US revealed intraperitoneal pelvic free fluid and bowel wall thickening, and the patient was administered intravenous fluid and monitored. However, the pain developed in intensity and became unbearable for the patient, and before the general surgeon was able to recheck the patient, the family refused further care and transferred to our hospital 20 hours after the accident. On examination, the patient was unable to walk, anxious, pale due to severe pain, dehydrated, tachycardic, and hypotensive. He

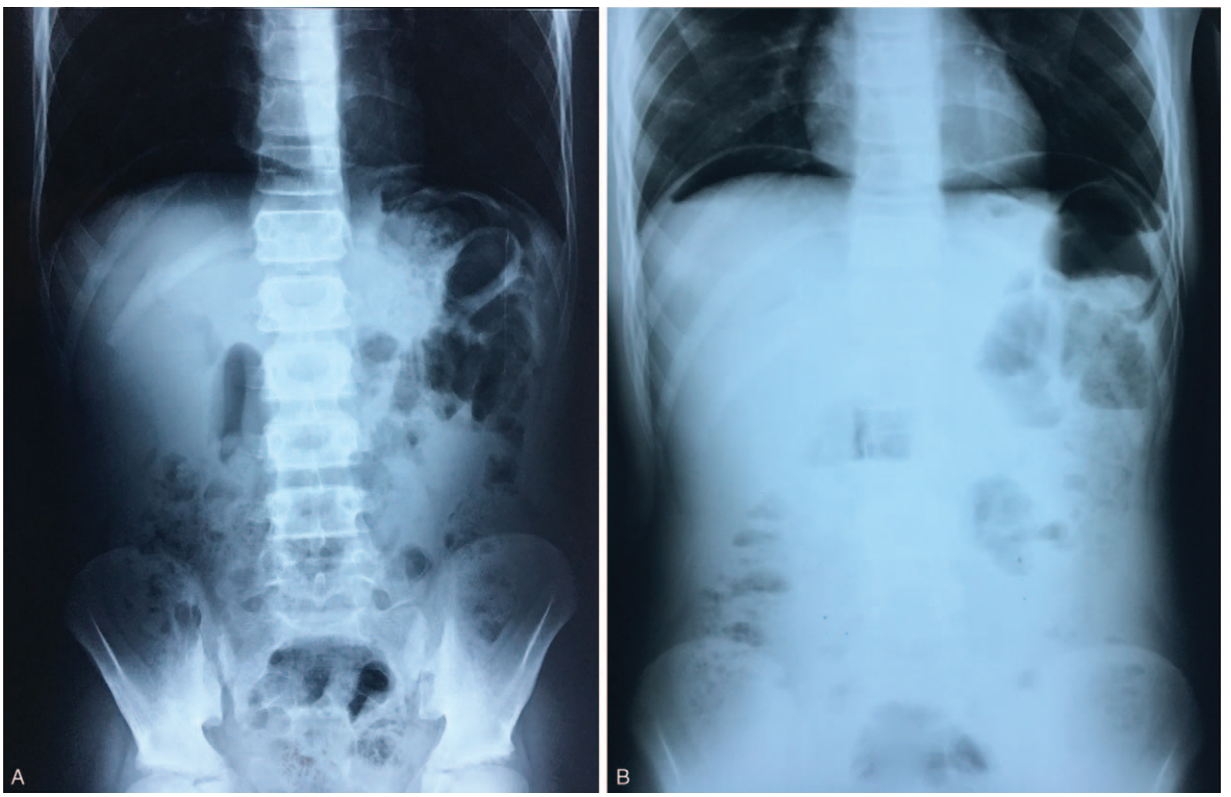

Figure 1. (A) Upright radiography of the abdomen shows the undetected pneumoperitoneum under both hemidiaphragms 4 h after the trauma. (B) Repeated upright radiographic scan of the abdomen shows a clearer image of the pneumoperitoneum under both hemidiaphragms with air-fluid levels 9 h after the trauma.

Table 1

Summary of clinical history and imaging and operative data.

Case	Age	Sex	First-second-third admission to a health center	Handlebar grip imprint	First imaging	Second-third imaging	Surgical findings	Follow-up
Case 1	8	M	4–18 h	(+)	Upright abdominal radiography, US	Upright abdominal radiography	Small bowel perforation	Recovered
Case 2	13	M	2–9 h	(+)	Supine chest and upright abdominal radiography, CT	Upright abdominal radiography	Small bowel perforation	Recovered
Case 3	16	M	1–9–20 h	Traumatic wall hernia	Supine chest and abdominal radiography	US-upright abdominal radiography, US	Abdominal wall hernia, small bowel, and sigmoid perforation	Recovered

CT = computed tomography, M = male, PO = postoperatively, US = ultrasonography.

had diffuse abdominal tenderness and peritonism. He reported that while he was performing an acrobatic maneuver on his bicycle, one of his slippers fell off, causing him to lose his balance and fall. UAXR in a sitting position revealed pneumoperitoneum and air-fluid levels the in intestine. US was repeated and revealed free fluid in the abdomen. Ileal and sigmoid perforations were detected on emergent exploratory laparotomy and were repaired with resection and anastomosis and with primary anastomosis, respectively. Peritoneal lavage was also performed. A drain was inserted into the rectovesical pouch. The postoperative period was uneventful, and he was discharged on the tenth postoperative day (Table 1).

3. Discussion

Handlebar traumas cause solid and hollow viscus abdominal traumas in children. Solid viscus traumas are more common and are generally associated with uneventful recoveries with conservative treatment. Meanwhile, hollow viscus traumas are less common but always require surgery, and early diagnosis is important because the morbidity and mortality rates increase proportionally with diagnostic delays.[6,9] However, pneumoperitoneum due to hollow organ injuries is sometimes difficult to detect. UAXR, US, and CT are the radiological imaging modalities used to detect bowel perforation.[10–12]

UAXR is a universally available, fast, cost-effective, and valuable modality for patient assessment. Moreover, it is easily accessible and does not need to be performed and interpreted by a radiologist.[11,12] Bansal et al recommend radiography as a first-line investigative modality at the primary health care level.[11] Dai et al also reported the importance of radiography for diagnosing hollow viscus perforations. They investigated 219 patients with abdominal injuries from bicycle handlebars; of these, 13 underwent emergency exploratory laparotomies due to hollow viscus perforations, and 11 were diagnosed with sub-diaphragmatic free air on the X-ray radiography.[9] However, the algorithm study by Miele et al recommends radiography only for cases of low-energy trauma.[10]

The interval between the accident and radiography, correct patient positioning, and an adequate standing position before exposure are all important factors to observe free air and make a reliable radiological interpretation.[12,13] In the present report, all patients underwent chest and/or abdominal radiography during their first admission at another hospital, but none of the radiographs obtained were helpful for diagnosis. Case 1, who had a distal ileal perforation, underwent an UAXR, but the radiography did not reveal free air at 4 hours after the trauma. In Case 2, free air under the diaphragm was evident in the UAXR in his first admission, but pneumoperitoneum was unnoticed during the rushed interpretation. Repeated UAXR in his second admission showed a clearer image of the pneumoperitoneum under both hemidiaphragms and the presence of air-fluid levels also helped the diagnosis. A reinterpretation of imaging studies is important for missed injuries.[13] Radiography for Case 3 was performed in supine positions due to the child's age or pain level. In cases in which keeping the patient in a standing position is difficult, radiography can be performed in the lateral decubitus or sitting position, as in Case 3.

In our cases, delay in diagnosis via UAXR has been due to the following reasons: an insufficient amount of air in the intestines, the need for more time for air to evacuate from the intestines into the peritoneal cavity, or an inadequate standing position before exposure.[10,12,13] Accurate diagnosis would have been achieved if they had undergone upright chest and/or abdominal radiography in a timely manner and correct positioning with careful interpretations of the findings.

Although US and CT are more advanced than radiography, there are some drawbacks. First, they are both operator and technology dependent,[14,15] and they require a contrast medium to improve diagnostic accuracy.[10,15] Moreover, they can show false-positive and false-negative results.[3,7,8] The detection of the free intraperitoneal air with US is difficult, and its diagnostic capability is limited in patients who are uncooperative or obese.[14] CT has the disadvantage of additional radiation exposure, high cost, hazardous reinvestigations and is not useful for unstable patients and during the early hours after trauma.[14]. US and CT also lead to increased dependence on diagnostic modalities and a loss of clinical acumen.[11]

US and CT were not helpful for early diagnosis in our patients probably because they were conducted within the early hours after the trauma.[14] Only US in Case 3 demonstrated indirect signs of intestinal trauma as free fluid between bowel loops 9 hours after the trauma, but it did not specifically identify the perforation. Although US is useful for unstable patients and has the advantage of no radiation risk, CT is the preferred diagnostic modality because it has higher sensitivity and accuracy for showing intraperitoneal free air.[2,3,9,10,16] Moreover, the site of perforation can even be detected on multi-sliced CT.[14] However, CT is the primary diagnostic modality of choice only in developed countries, and UAXR remains to be among the first diagnostic options in developing countries.[2,17]

In the current report, all cases of intestinal perforations were diagnosed by the surgeon via UAXR, without the need for more time, a radiologist, and complicated imaging modalities. Cases 1

and 2 were admitted outside of the working hours only for X-ray radiography could be performed. Case 3 was admitted during working hours; thus, both X-ray radiography and US were performed. After the preoperative resuscitation, all patients underwent surgery with exploratory laparotomy. The indications for surgery in Cases 1 and 2 were small bowel perforations, while it was perforations in both the small and large bowel in Case 3. All the perforations were repaired either with primary closure or bowel resection and anastomosis without ostomy.

A diagnosis of blunt handlebar trauma is often delayed because there is typically no associated major blood loss.[4,8] Our patients were hemodynamically stable in the initial hours of the accident, and they only complained of mild-moderate abdominal pain. Complaints of even mild abdominal pain in isolated abdominal traumas and after such accidents should be taken seriously. Cases 1, 2, and 3 underwent operations within 24 hours with successful outcomes.

Although this report is limited to cases that were diagnosed late, we recommend that all handlebar traumas regardless of whether they have handlebar imprint or not be observed within 24 hours following the trauma because imaging of the air that exit from the intestinal system into the closed intraperitoneal space also depends on the number of hours after the trauma by which the images are taken.

Three patients had handlebar imprints or abdominal wall hernias due to the handlebar trauma, which was in accordance with the literature.[5,9] In this case series, all the cases showed clear anamneses and abdominal handlebar imprints or hernias. However, the hidden pathology prevented an early diagnosis.[3] The patients and their families realize the handlebar imprint for the first time during initial assessment in our hospital. Given that a delayed complaint may result in fatal outcomes, children and their caregivers should be informed about the significance of handlebar imprints.

Handlebar traumas usually occur during summer and are more common in boys than girls.[16,17] In the present report, the accidents also occurred in summer season, and all patients were boys. Hirose et al reported that children riding bicycles have a higher risk of accidents than adults because they adhere to fewer rules and engage in riskier behaviors.[2] In this study, Case 1 lost his balance due to careless riding, Case 2 was distracted as he was busy setting up his earphones while cycling, and Case 3 had an accident due to the combination of inappropriate footwear and the performance of an acrobatic maneuver. All patients were careless, which was the main reason of their injuries. Children should be continuously reminded of cycling rules, safety issues, handlebar risks, and suitable clothing in an age-appropriate manner, particularly before the summer season.

Although most reports on handlebar trauma emphasize mortality and morbidity risks, mortality due to handlebar trauma has not been reported in these recent case reports and large series.[2–9,16,17] This may due to increasing awareness and timely admission or that mortality cases have not been reported.

This study has all of the recognized limitations of a retrospective case series. The sample size is small, and all patients were operated on and followed up by 1 pediatric surgeon. Only the patients who were diagnosed on their second and third admission were included in this study. Our hospital is a public children's hospital and provides pediatric surgery 24-hours a day for surrounding cities and towns. However, working hours in other departments are limited and imaging modalities are not available 24 hours a day. US is performed by on-call radiologists, and patients who require CT are transferred to another center. Therefore, patients were initially evaluated with radiography, and in situations wherein accurate diagnosis was obtained, no further investigations were performed.

4. Conclusion

UAXR should be considered as a primary diagnostic modality for blunt intestinal perforations in resource-limited institutions and emergency situations. The amount of and time by which pneumoperitoneum can be detected via radiography varies with each case. Patients should be monitored for at least 24 hours, and UAXR be repeated thereafter. A simple plain abdominal radiography performed in the proper time can save a patient's life.

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Author contributions

Conceptualization: Feride Mehmetoğlu.
Data curation: Feride Mehmetoğlu.
Formal analysis: Feride Mehmetoğlu.
Investigation: Feride Mehmetoğlu.
Methodology: Feride Mehmetoğlu.
Project administration: Feride Mehmetoğlu.
Resources: Feride Mehmetoğlu.
Software: Feride Mehmetoğlu.
Supervision: Feride Mehmetoğlu.
Validation: Feride Mehmetoğlu.
Visualization: Feride Mehmetoğlu.
Writing – original draft: Feride Mehmetoğlu.
Writing – review and editing: Feride Mehmetoğlu.
Feride Mehmetoğlu orcid: 0000-0002-8387-5296.

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