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Case Report

Transabdominal impalement injury by an iron pipe - A case report

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ABSTRACT

Impalement injuries are rare and complex problems, often involving multiple organ injuries. An 18-year-old male was admitted to our emergency department after a car accident. Positioned in the right-side recumbent position, he had a 4.5 cm diameter pipe penetrating from his left abdomen to his back. Given the pipe's length exceeding the CT gantry's capacity, further imaging tests were not feasible. Consequently, the patient proceeded directly to the operating room without preoperative imaging. Before laparotomy, a left thoracotomy was conducted for aortic cross-clamping, anticipating uncontrollable bleeding during pipe removal. The subsequent laparotomy, with the patient in the right-side recumbent position, revealed the pipe impaling through the mesentery of the descending colon without evident major vessel injury. The pipe was cautiously extracted. The patient was subsequently discharged on day 26. The absence of imaging feasibility emphasized that current hemodynamic stability does not rule out the potential for significant vessel injury. Therefore, the sequential approach of left thoracotomy for aortic cross-clamping followed by laparotomy emerges as a potentially beneficial strategy in cases of transabdominal impalement. The impalement injury requires our preparedness and flexibility, which should be tailored to the individual case.

Introduction

Impalement injuries are rare and are produced by the object penetrating and remaining in the patient's body [1,2]. This type of injury of the abdomen has the component of both penetrating injury as well as blunt injury and is a complex problem due to multiple organ injuries [3]. Due to diverse injury patterns, there is no standardized strategy for abdominal impalement injuries [2]. Thus, the surgical approach is always challenging and should be tailored to presenting injuries [1,2]. We report a case of transabdominal impalement injury by the iron pipe without the feasibility of an imaging test and performed a left thoracotomy preparing for aortic cross-clamping followed by laparotomy in the right lateral decubitus position.

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Case

An 18-year-old male with no significant medical history was admitted to our emergency department following a car accident. While driving, he veered off the road without negotiating a curve and crashed into a material storage area at the construction site. An iron pipe impaled the patient's trunk and seat. The patient rescued from the accident scene, took approximately 2 h to reach the hospital after the collision (Fig. 1).

Upon arrival, his Glasgow Coma Scale score of 14 (E3, V5, M6), heart rate was 102 bpm, blood pressure was 138/96 mmHg, respiratory rate was 35/min, and oxygen saturation was 99 % with the 10 L of oxygen. The lab data of this patient revealed no anemia or coagulopathy (Table 1).

The patient was positioned in the right-side recumbent position with the approximately 4.5 cm diameter pipe penetrating from his left abdomen to his back. Intestinal prolapse and bleeding from the wound were detected. Focused assessment with sonography in trauma did not reveal any abnormalities. Due to the pipe's length exceeding the CT gantry's diameter, further imaging tests was not feasible.

Consequently, the patient was directly taken to the operating room without preoperative imaging, limiting the information regarding the damaged organs. In the tilted position, we could not cannulate the right femoral artery. Thus, we abandoned the idea of inserting REBOA from femoral vascular access. Therefore, a left thoracotomy was performed for aortic cross-clamping in case of uncontrollable bleeding pipe removal. Subsequently, laparotomy was performed with the patient in the right-side recumbent position under general anesthesia. A skin incision was made directly above the pipe, followed by incisions of the abdominal oblique and latissimus dorsi muscles to access the abdomen (Fig. 2).

The pipe was found to be impaled through the mesentery of the descending colon. Without obvious major vessel damage observed, the pipe was slowly removed. Injuries included rupture of the descending mesentery including the marginal artery and vein requiring ligation and hemostasis; crushing of the small intestine and small mesentery necessitating partial resection of the small intestine and anastomosis; rupture of the left ureter repaired through ureteral anastomosis with insertion of a urethral stent; crushing of the lower pole of the left kidney managed by achieving hemostasis with a Tachosil®, Tissue sealing seat (CSL Behring, USA) and a fracture of the left 12th rib addressed by resecting the fractured segment (Fig. 3).

Due to the compromised abdominal wall at the site of pipe penetration, fascial suture closure was not possible. Thorough irrigation and debridement of the crushed tissue were performed, and drains were placed around the kidney and in the rectovesical pouch. The surgical site was closed by suturing the fascia of the oblique muscle with 0-PDS and skin stable was used for the dermal suture. However, the penetrating site was sutured for only the skin. However, follow-up of the patient did not present a hernia at the scar. The patient was transferred out of ICU on day 5 and subsequently discharged from the hospital on day 26 (Figs. 4, 5).

Discussion

Herein, we present a case of transabdominal impalement injury caused by an iron pipe. A left anterior thoracotomy was performed as a precautionary for aortic cross-clamping in case of uncontrollable bleeding, followed by an irregular position laparotomy with the patient in the right-side recumbent position.

Impalement injuries involve the penetration and embedding of elongated objects into the human body [2,4]. Typically associated with industrial falls or car accidents [1], these injuries often affect abdominal organs, and major blood vessels [5,6]. In the

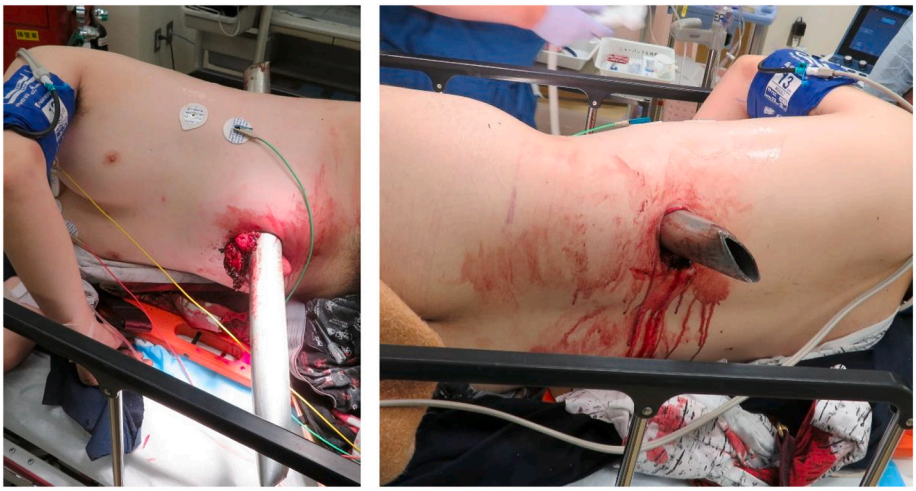

Fig. 1. Patient positioning and initial presentation.
The patient was positioned in the right-side recumbent posture, with an approximately 4.5 cm diameter pipe penetrating from his left abdomen to his back. The intestinal prolapse and bleeding from the wound were detected.

Table 1
Laboratory examination on ER admission.

Hematology		
White blood cell	8910	/μL
Hemoglobin	10.5	g/dL
Platelet	238	$\times 10^3$/μL
Coagulation		
PT	76	%
PT-INR	1.09	sec
APTT	30.5	sec
Fibrinogen	245	mg/dL
Serum chemistry		
Albumin	2.8	g/dL
Urea nitrogen	19	mg/dL
Creatinine	1.18	mg/dL
Na	139	mEq/L
K	5	mEq/L
Chloride	108	mEq/L
Total bilirubin	0.7	mg/dL
Direct bilirubin	0.1	mg/dL
Chloride	103	mEq/L
Alkali phosphatase	366	IU/mL
AST	66	IU/mL
ALT	35	IU/mL
LD	364	U/L
Amylase	57	IU/L
Creatine kinase	3093	IU/L
Blood gas analysis (arterial blood under 10 L/min oxygen)		
pH	7.426	
$PaCO_2$	37.6	mmHg
PaO_2	270	mmHg
Glucose	133	mg/dL
Bicarbonate ion	24.2	mmol/L
Lactate acid	22.6	mg/dL

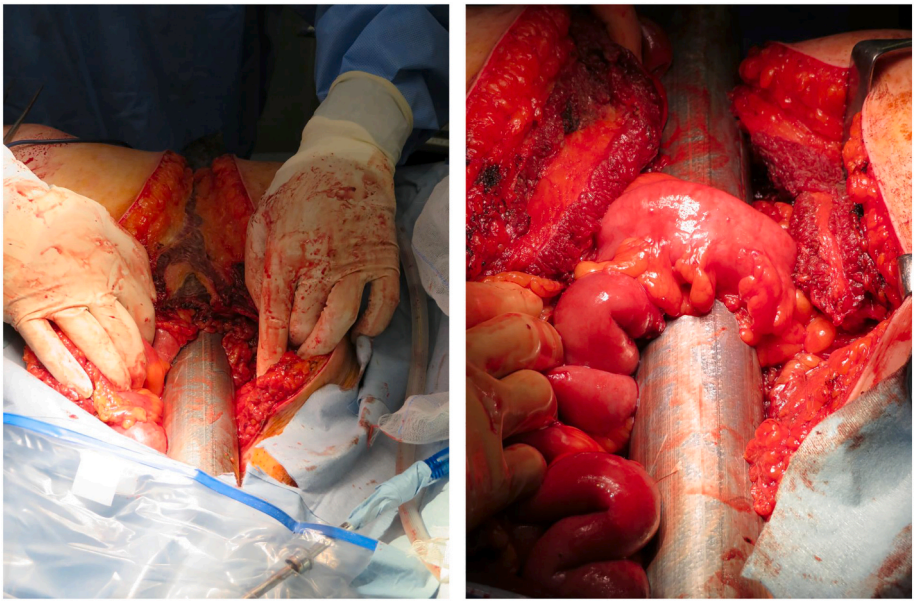

Fig. 2. Surgical approach.
a. Skin incision directly above along the pipe.
b. Abdominal oblique and latissimus dorsi muscles.

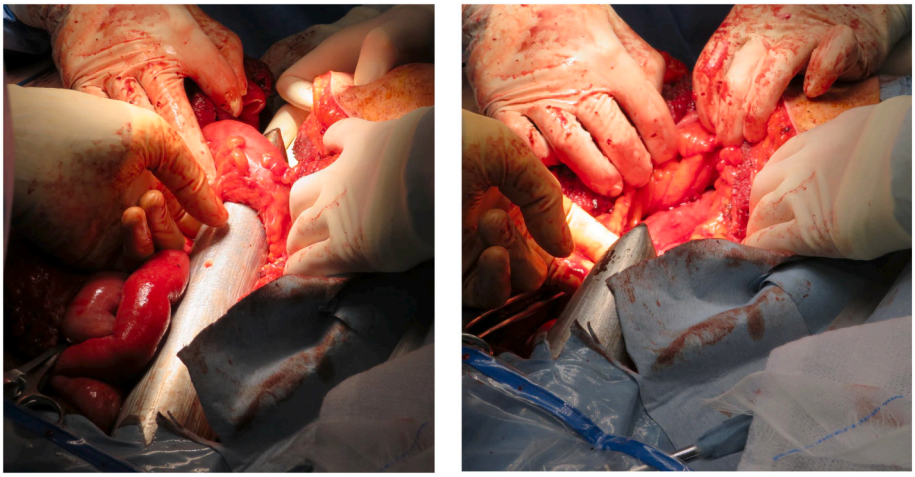

Fig. 3. Intraoperative details.
a. The pipe traversed through the mesentery of the descending colon, and no apparent damage to major vessels was observed.
b. Gradual removal of the pipe was conducted, ensuring the absence of bleeding.

Fig. 4. Description of the penetrating iron pipe.
The iron pipe, depicted in this figure, exhibited a diameter of 4.5 cm and a length of 80 cm.

management of abdominal impalement injury, a crucial rule is to avoid removing the impaled object before surgery. The tamponade effect created by the object can play an essential role in hemostasis within the abdominal cavity [1,5,7]. Consequently, the patient's hemodynamic stability does not exclude the possibility of significant vessel injury.

Generally, it is recommended to shorten impaling objects to facilitate transport without compromising tamponade [4,8]. However, in this case, even after cutting the pipe, this patient could not undergo a CT scan due to the pipe's size exceeding the gantry capacity. Furthermore, shortening the pipe further would require cutting quite close to the body surface at both ends, which is unrealistic based on the material and thickness of the pipe. While contrast-enhanced CT is valuable for assessing organs and vessel damage [6], surgery was necessitated in this case without preoperative CT information on the extent of organ injury. In hindsight, considering an X-ray was an option, it's speculated that the lateral X-ray would not have significantly altered the surgical approach in the operating room.

Due to the penetrating nature of the pipe, patients with impalement injuries must be positioned laterally when lying down [5]. In this case, the patient was in the right lateral decubitus position. The operative removal of impalement objects, as seen in this case, often limits the available surgical positions. In cases of impalement injury, a standardized surgical approach may not be applicable due to the unique and diverse nature of injuries. Thus, surgeons are often required to adopt a tailor-made surgical approach. Thus, when the patient is stable, meticulous preplanning, involving a multispecialty team, should be undertaken to tailor the approach to the presenting injuries [2]. In this case, the abdomen was opened directly above the impaling pipe while the patient was in the same position and the pipe was safely removed through direct visualization of the insertion route.

In this particular case, a left anterior thoracotomy was performed as a preparatory step for aortic cross-clamping followed by laparotomy. As we referred to above, the extraction of impalement objects carries the risk of haemorrhage from the major vessels due to the release of tamponade effects. Thus, emergent cases may necessitate a prompt and reliable clamping technique. In situations where the prone position is feasible, a less invasive approach involves utilizing resuscitative endovascular balloon occlusion of the aorta (REBOA). When the supine position is unavailable, as seen in this case, left thoracotomy may offer advantages in select scenarios. Alternatively, the placement of REBOA from the brachial artery could have been considered. However, established and rapid procedures in each facility are desirable.

Retrospectively, the hemodynamically stable and distal pulsed heart rate of this patient and negative FAST did not indicate a major vascular injury. Thus, the patient might be overly triaged, and thoracotomy was not necessary as a result. However, we did not have a lot of cases of impalement injury. Thus, further investigation of indication of thoracotomy for impalement injury is required.

Impalement injuries, by nature, pose risks of penetrating the gastrointestinal tract, leading to the inevitability of intra-abdominal infection, and surgical site infection [6]. Consequently, surgical debridement and drainage become imperative. Furthermore, due to

Fig. 5. Postoperative follow-up.
The scar resulting from the thoracotomy and laparotomy procedures was evident during the follow-up outpatient examination.

wound contamination, the administration of antibiotics, tetanus toxoid, and anti-tetanus immune globulin is necessary [1,6].

Conclusion

We present a case of transabdominal impalement injury by an iron pipe. In the absence of imaging feasibility, the maintenance of hemodynamic stability does not exclude the potential for significant vessel injury. Consequently, performing a left thoracotomy for aortic cross-clamping followed by laparotomy may be beneficial for patients experiencing transabdominal impalement and who are unable to reposition due to the impaling object. The impalement injury requires our preparedness and flexibility, which should be tailored to the individual case.

Abbreviations

None.

Ethics approval and consent to participate

Not applicable.

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Consent for publication

Consent to publish was obtained from the patient reported in this study.

CRediT authorship contribution statement

Yuki Itagaki: Writing – original draft, Data curation, Conceptualization. **Nagato Sato:** Writing – review & editing, Supervision. **Ritsu Ohmine:** Writing – review & editing. **Takuya Ikushima:** Writing – review & editing. **Tsukasa Kaneko:** Writing – review & editing. **Tomohide Shirosaki:** Writing – review & editing. **Hironori Tanaka:** Writing – review & editing. **Hirofumi Morimoto:** Writing – review & editing. **Naoya Fukuda:** Writing – review & editing. **Yasuaki Iimura:** Writing – review & editing. **Satoshi Hirano:** Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Not applicable.

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Not applicable.

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