Difficulties in the Management of Impalement Injuries Sustained in Rural India

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Abstract

Impalement injury is said to occur when a blunt force causes a long object to penetrate a body part resulting in retention of the object in situ. We report two unusual cases of impalement from rural India: one, chest impalement by a hunting spear and the other, an extremity impalement by a rotatory tiller blade. Thoracic impalement injuries are very rare, and there is only one other published report of chest impalement by a spear (trident) in the modern era. There are only two published reports of extremity impalement by a rotatory tiller blade. We also describe the difficulties encountered in their management. Patient-1 sustained accidental impalement to the right hemithorax by a spear used for hunting wild boars, leaving a meter long shaft protruding from his body. This necessitated his transfer to the hospital on the cargo bay of a pickup truck and also precluded complete radiological investigations before surgery. In addition, the reversed barbed tip of the spear made the extraction difficult. Patient-2 sustained impalement through the right knee by a rotatory tiller blade which bound him to the machine. The blade had to be disconnected from the shank assembly of the tiller to extricate him. Due to the proximity of the blade to the popliteal vessels, vascular control was necessary before extraction. Both the patients took several hours to reach the hospital as the accident occurred in remote rural areas. However, both had a successful outcome after surgical removal of the impaled object by a multidisciplinary involvement. We also have reviewed the published literature and given our suggestions for the management of these unusual and difficult injuries.

Keywords: Case report, extremity impalement, spear impalement, thoracic impalement, tiller blade impalement

Introduction

Impalement injury (II) occurs when a significant blunt force causes a long object to penetrate into a body part resulting in the retention of the object in situ.[1,2] The earliest reference to impalement as punishment dates back to 18th century B.C. in Hammurabi’s code of law, article 153.[3] Impalements commonly involve extremities, thoracic impalement (TI) being very rare.[4,5] We report two unusual cases from rural India: one of TI and the other of extremities.

Case Reports

Case-1

A 38-year-old male came to the emergency room (ER), 8 h after injury, in a pickup truck after accidental TI by a spear of 1 m length, 2.5 cm diameter with a metallic reversed barbed tip of 5 cm. He had pulse rate – 100/min, blood pressure – 90/60 mmHg, respiratory rate – 20/min, and SPO$_2$ – 96 mmHg. The spear had entered through the thorax through the right fifth intercostal space, 5 cm lateral to the right mid-clavicular line [Figure 1a and b]. On examination, air entry was decreased in the right hemithorax. The patient was resuscitated as per the trauma protocol. Chest X-ray [Figure 1c] showed the spear tip lying close to the mediastinum with minimal hemothorax and lung contusion on the right side. Electrocardiogram was normal. Abdominal
ultrasound (Focused Assessment with Sonography for Trauma) showed minimal hemoperitoneum. The protruding spear prevented access to the computed tomography (CT) gantry for angiography and needed continuous support till surgery for its extraction [Figure 1a]. An emergency right posterolateral thoracotomy through the right fifth intercostal space under general anesthesia showed: contusion of the lower part of the right middle lobe of the lung [Figure 2a], minimal hemothorax, the reversed barbed tip hooked to the right hemidiaphragm, and a small liver laceration without active bleeding. The tip was released after careful exposure. The lung laceration and diaphragmatic rent were repaired [Figure 2b]. After wound debridement, thorough pleural lavage with normal saline, two intercostal drainage tubes were placed. He was put on elective mechanical ventilation for a short period. He also received tetanus prophylaxis and broad-spectrum antibiotics. The patient had an uneventful recovery and was discharged after 7 days. At 6-month follow-up, he was fully functional with no sequelae.

Difficulties in case-1
1. The long shaft of the spear posed difficulty in transport
2. Several hours delay in shifting the patient as the accident occurred in a remote location
3. Spear needed continuous support to minimize damage to intrathoracic viscera by inadvertent movements
4. Length of the spear precluded CT angiography. Specific organ injury could only be surmised preoperatively based on the trajectory
5. Heavy contamination of the wound track
6. The reversed barb tip posed difficulty for its extraction.

Case-2
A 45-year-old male farmer was brought to the ER after accidental impalement of the right lower limb by a heavy rotatory tiller blade 8 h earlier. He had to be extracted with the blade in situ by separating it from the machine. He was hemodynamically stable. The curved “J” shaped blade had passed posteriorly through the popliteal fossa from medial to lateral with the knee in fixed flexion [Wound A-Figure 3a]. There was another soft-tissue muscle deep laceration on the lateral aspect of the right leg below wound-A [Wound B-Figure 3a]. Distal arterial pulses in the affected lower limb were slightly diminished. Toe movements and distal sensations were normal.

X-ray right leg [Figure 3b] showed the blade passing through the right knee joint obliquely. CT angiogram of the right lower limb [Figure 3c] confirmed the fracture of the articular surface of the tibia and suggested close proximity of the right popliteal artery to the blade. However, distal flow in the popliteal artery was present.

For surgery, he was intubated with the impaled right leg manually supported, away from the operation table, before turning into prone position carefully. As vascular injury was a possibility, proximal and distal vascular control of the popliteal artery was obtained by separate incisions above and below the impaled blade. As the blade was both rough and curved, the skin was incised directly over the blade connecting exit and entry wounds and deepened till the blade to extract it under direct vision while protecting neurovascular structures. The vascular bundle was just deep to the blade but found intact by the release of the vascular controls [Figure 4]. Free lying fracture fragments of the articular surface of the tibia were removed. Wounds A and B were debrided and irrigated copiously with saline. Partial wound closure was done to prevent compartment syndrome. Wound B was also left open to drain. The limb was immobilized in slight flexion at the knee. Postoperatively, the patient was heparinized for 72 h. He also received broad-spectrum antibiotics and tetanus prophylaxis. The patient was discharged after partial delayed primary closure of the wound on the 7th postoperative day uneventfully.

Difficulties in case-2
1. The patient had to be extracted from the tiller machine with the blade in situ
2. Delay in transport from a remote area
3. Difficulty in anesthesia
4. Possibility of vascular injury required vascular control before the extraction of tiller blade

Figure 1: (a) Long shaft of the spear being supported while positioning for surgery (b) trajectory of the spear passing through the right fifth intercostal space and the right middle lobe (c) Chest X-ray showing reversed barb tip of the spear, right hemothorax, and lung contusion

Figure 2: (a) Contused lower part of the upper lobe of the right lung (black arrow) after extraction of the spear (b) sutured diaphragmatic rent (black arrow)
5. The rough and curved shape of the blade required modification of the surgical plan
6. The articular surface of the tibia was fractured with multiple loose bony fragments which required removal
7. Heavy contamination of the wounds
8. Multispecialty care was required due to the complexity of the injury.

**Discussion**

The spear injuring Patient-1 had a long, lightweight hollow metal shaft with a heavy, sharp, barbed metal tip. It was used as a handheld projectile for wild boar hunting, injuring the patient accidentally in poor light.

Patient-2 was injured accidentally when he came in the way of the powered agricultural tiller system comprising an array of blades, three in each set, arranged along a shank. He was injured by two sets in tandem, resulting in one blade passing through the knee and another blade of the adjacent set scraping the leg, causing wounds A and B, respectively [Figures 3a, 5a and b].

**Classification of Impalement**

- Type-1 injury where the moving human body falls on to the object and gets impaled, e.g., fall from a height
- Type-2 injury where the moving object impales the stationary human body, e.g., road traffic accidents.

Both our cases come under Type-2 injuries.

Impalement can also be classified as simple or complex. In complex impalement, the human body is transfixed in an inescapable position and needs to be disengaged to facilitate transport to the hospital. Patient-1 is an example of simple impalement and Patient-2 is an example of complex impalement.

No attempt should be made to remove the impaled object (IO) at the accident site as it can cause uncontrolled bleeding or additional tissue damage. The patient has to be transferred to the hospital with the IO in situ and supported adequately to prevent inadvertent internal damage. In some instances, it may be necessary to shorten the protruding part carefully to help transfer.

In the hospital, initial resuscitation should follow principles of basic life support. Investigations are needed as per the site of impalement, trajectory, and possible injuries. Investigations may be curtailed in an unstable patient or if the IO comes in the way before surgical exploration as in Case-1.

All impalement injuries require surgery. The IO may come in the way of positioning for anesthesia as in Case-2. The patient’s position on the operation table depends on the size and trajectory of the IO and the procedure intended.

The IO should be only removed in the controlled environment of the operation theater under direct vision. Multicavitary injury may need complex decision-making and involve multiple specialists. Thorough debridement and lavage are
very important steps to decrease sepsis. The primary repair of injured structures should be done as far as possible.\[12\] In Patient-2, delayed primary closure was done due to heavy contamination. Postoperative coverage with broad-spectrum antibiotics and tetanus prophylaxis is mandatory.\[2,11,16\] Prognosis depends on the site of impalement, organ damage, and contamination.

Both our patients had a good outcome. TI is far more dangerous than limb impalement as the former is associated with life-threatening hemorrhage, cardiac complications, or respiratory embarrassment. Complications in the latter are usually restricted to the affected limb.\[9\] Good prognostic indicators after TI injury are as follows:
1. Young age
2. Rapid transfer to the hospital
3. Right-sided thoracic injury
4. Absence of mediastinal involvement.\[12,17\]

**Conclusion**
1. The basic protocol of trauma management should be adhered to in all trauma cases including II
2. Impalement injuries may involve multiple cavities and multiple viscera depending on the IO and its trajectory
3. Radiological investigations play an important role in surgical planning
4. The IO should always be removed in controlled conditions of the operation theater
5. Availability of blood and blood products and multispecialty trauma team are essential to deal with such complex injuries.

**Research quality and ethics statement**
The authors of this manuscript declare that this scientific work complies with reporting quality, formatting, and reproducibility guidelines set forth by the EQUATOR Network. The authors also attest that this clinical investigation was not determined to require the institutional review board/ethics committee review, and the corresponding protocol/approval number is not applicable. We also certify that we have not plagiarized the contents in this submission and have done a plagiarism check.

**Declaration of patient consent**
The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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**Conflicts of interest**
There are no conflicts of interest.

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