A rare case of penetrating intra-abdominal trauma by a fishing speargun

Sohil Pothiawala, Ian Civil

ABSTRACT

INTRODUCTION: Spearfishing is a popular sport in New Zealand. While there have been a few reported self-inflicted speargun injuries causing fatal intracranial damage, accidental speargun injuries while fishing are even less common. Intra-abdominal speargun injuries are even less common. Its occurrence in a 30-year-old male patient reported here highlights the potential risk of life-threatening injuries.

CASE REPORT: A 30-year-old male sustained an accidental speargun injury, with the spear passing through central small bowel loops and its pointed tip penetrating the left iliac wing. The patient underwent laparotomy, and the spear was removed in an antegrade fashion with primary closure of small bowel enterotomies and repair of the mesenteric defects. He had a re-look laparotomy 48 hours later with resection and anastomosis of two primary small bowel repairs and was eventually discharged after 12 days.

DISCUSSION: Information obtained by radiological evaluation using computed tomography (CT) scan and angiography regarding the spear trajectory, injured organs, vasculature and spear tip mechanism is important to decide the best surgical approach. The spear should be removed in an antegrade fashion, because pulling the spear in the retrograde direction can cause further tissue and/or vascular injury. Currently, there is no legislation regarding the use of spearguns and users do not require a license, despite the potential for severe penetrating trauma similar to that caused by firearms.

CONCLUSION: Spearguns can produce life-threatening injuries and the removal of the spear depends on the location of the tip in relation to adjacent structures and whether the flapper is open. It often requires a multidisciplinary team approach. Safety guidelines need to be published and widely available, and the potential risks of speargun injuries should be included in fishing rules. Introducing license requirement for possession and handling of this firearm-like weapon also needs to be considered.

Spearfishing is a popular sport in New Zealand. While there have been a few self-inflicted speargun injuries causing fatal intracranial damage, accidental speargun injuries while fishing are even less common. These cases suggest that the trajectory of the spear and the extent of cranio-facial injuries are different between self-inflicted and unintentional injuries. They suggest a multidisciplinary team approach may be required, and the surgery should preferably be performed in a hybrid operating room. The best surgical approach and direction of removal (anterograde vs retrograde) of the spear depends on the type of spear tip, its location and its closeness to adjacent structures.

Intra-abdominal speargun injuries are less common than cranio-facial injuries but their occurrence, such as in the case reported here, highlights the need for users to be familiar with safe practice. Currently there is no legislation regarding the use of spearguns and users do not require a license, despite the potential for severe penetrating trauma similar to injuries caused by firearms. Moreover, in the current New Zealand “spearfishing code of practice”, there is minimal information regarding the safe use of spearguns and the potential risk of life-threatening injuries.

Case report

A 30-year-old male was holding a loaded speargun and putting it in the backseat of his car when the spear accidentally discharged. The patient was unsure whether the safety catch of the speargun was on. The spear entered the patient’s body through the right upper quadrant of the abdomen (Figure 1).

The back end of the spear’s shaft was cut short by firefighters to facilitate transport to the hospital. An initial focussed abdominal sonography for trauma (FAST) done by the paramedics at the scene was negative. On arrival in the emergency department (ED), the patient was alert and vital signs showed a heart rate of 90 beats/minute, a respiratory rate of 20 breaths/minute, a blood pressure of 130/70mm Hg and an oxygen saturation of 98% on room air. Examination showed the spear traversing towards the left lower abdomen. FAST done in the ED showed free fluid in the abdomen. Routine trauma blood tests including haemoglobin were all normal and a contrast-enhanced computed tomography (CECT) scan of the abdomen and pelvis showed a 10mm metallic spear penetrating the abdominal cavity with a 45 degree trajectory from right to left (Figure 2).
Figure 1: Spear entering the patient's body through the right upper quadrant of the abdomen.

Figure 2: Computed tomography (CT) scan showing the trajectory of the spear from the right to the left side of the abdomen.
Figure 3: CT scan of abdomen and pelvis showing the spear passing through the central small bowel loops in proximity to the mesenteric root (A), and the pointed tip of the spear penetrating through the left iliac wing (B).

Figure 4: Speargun shaft tip with a single or double flapper (flopper) tip, which opens on contact and holds the fish, thus preventing it from slipping out of the pointed shaft. (Image courtesy: https://Maxspearfishing.com.)
The spear passed through central small bowel loops in proximity to the mesenteric root causing small bowel injury (Figure 3A), and its pointed tip penetrated through the inferior aspect of left iliac wing (Figure 3B), extending 6cm into the left gluteal muscles. There was a small volume of hae-moperitoneum. There was no arterial phase blush or pooling of contrast on the portal venous phase suggestive of active bleeding, and there was no solid organ injury or retroperitoneal haematoma. The spear tip had a spring-flapper (flopper) that was capable of opening on contact, but this flapper was not deployed in our patient, thus limiting damage. Three-dimensional (3D) CT reconstruction could reveal details of the spear tip and flap-pers, but this was not performed.

The patient was transferred to the operating theatre for damage control surgery, which is a staged operative technique for rapid initial control of life-threatening injuries and haemorrhage, followed by definitive surgery once the patient is physiologically stable. Trauma surgeons performed a laparotomy and the spear was removed in the antegrade fashion along the path of penetration, with primary closure of five small bowel enterotomies, washout of soiling and repair of the mesenteric defects. The iliac wing fracture was debrided but did not need any other orthopaedic intervention. Post-operatively, the patient was transferred to the intensive care unit and intravenous antibiotics (ceftriaxone and metronidazole) were continued. The patient underwent a re-look laparotomy 48 hours later, with resection and anastomosis of two primary small bowel repairs and abdominal closure. The patient had no underlying psychiatric illness and he did not have any suicidal ideation. Thus, this incident was determined to be an accidental. He was discharged following 12 days of hospitalisation, with an outpatient follow-up with the Trauma Service.

**Discussion**

In patients presenting with penetrating trauma, the external wound is a marker of internal injuries. The trajectory of a bullet or knife may be uncertain, but in this case, the spear provided unequivocal evidence of its trajectory. The initial assessment of patients with impalement injuries includes: assessment of hemodynamic instability; and identification and management of life-threatening injuries like tension pneumothorax, massive haemorrhage, pericardial tamponade or major vascular injuries causing ongoing haemorrhage. It would also be important to consider the identification of spinal-cord injuries in penetrating trauma. The priorities of management include damage control resuscitation of haemodynamically unstable patients with judicious fluid resuscitation, early use of blood products and immediate transfer to the operating theatre (OT) for haemorrhage control. Patients with penetrating trauma who present with witnessed cardiac arrest may require resuscitative thoracotomy.

A fishing speargun is an atypical firearm that uses pneumatic compression or a rubber band-propelled elastic mechanism, and it can propel spears at a speed of up to 975 metres per second.\(^8\) As it is used underwater, the force with which the spear is shot must overcome the water resistance. However, if the speargun fires in the absence of this water resistance, as in our case, it can potentially lead to more severe injuries. The spear has a barb or spring-flapper (flopper) near its pointed tip (Figure 4).

The impaled spear causes cutting and stab-bing wounds, and the flapper can damage the viscera and vascular structures if extracted without precautions.\(^9\) The impaled object must not be removed initially, as it helps maintain a haemostatic effect. The spear may need to be shortened in length to facilitate transfer, and it is also important to stabilise the entry and exit points of the object. Radiological evaluation using a computed tomography (CT) scan provides important information regarding the spear’s trajectory and estimated damage, while angiography helps identify the possibility of a vascular injury and the relation between the spear and vessels.\(^4,10\) If the patient is haemodynamically unstable where the penetrating object is still in-situ, CT scan is not indicated and the patient must be transferred directly to the OT. Our patient was haemodynamically stable in the ED, and hence underwent a CT scan first. Information regarding spear trajectory, injured organs and vasculature and spear tip mechanism are important to decide the best surgical approach.

The spear tip mechanism can affect retrograde withdrawal of the spear, as the barb or spring-flapper tip could lead to potentially serious injuries.\(^3\) In our patient, the spear tip had a spring-flapper which was capable of opening on contact. Fortunately for our patient the flapper was not deployed, thus limiting damage. Hence, it is recommended to remove the spear in an anterograde fashion, because pulling it in the retrograde direction can cause the flapper to spread.
In patients with associated vascular injury identified on CT angiography, or objects in-situ with a high risk of vascular injury, it would be advantageous to undertake the surgery in a hybrid OT where the multidisciplinary team is capable of performing endovascular evaluation and treatment along with surgery. Angiography can also be performed immediately after removal of the spear to determine any ongoing bleeding.

A case of an intra-abdominal speargun injury reported that the spear caused minimal damage to the third hepatic segment and lodged within 4mm of the abdominal aorta without any vascular injury. Another patient sustained a thoraco-abdominal impalement of the spear, causing injuries to the lung, oesophagus, diaphragm and the liver. The surgical incision must allow perfect vision of the spear, the injured organs and viscera adjacent to the spear tip. In cases of associated vascular injuries, it is also important to have good control of the proximal and distal vasculature, and the spear must then be removed under direct vision to limit any further injuries. A report of eight cases of penetrating abdominal spear injuries identified retroperitoneal haematoma as a common finding during laparotomy. In contrast to these reported cases, the spear passed through the small bowel loops, causing perforation and mesenteric injury in our patient. The tip of the spear also caused fracture of the left iliac wing requiring intra-operative assessment by the orthopaedic surgeon. Our patient did not have any other solid organ or vascular injury. Despite the dangerous trajectory of the spear, he had a good outcome after surgical management. Every patient with such an injury will be unique, and the definitive management should be tailored to the individual patient.

Various strategies available to prevent such injuries include education, product modification and legislation/regulation. Injury prevention strategies like educational campaigns for the community are often effective but require a voluntary change of individual behaviour. We also need to focus on a systems approach, which includes policy and legislation. Mandating safe practice and implementing safety standards can prevent unintentional injuries. Legislation regarding seat belt and helmet use has led to a substantial decrease in mortality for road crashes, and a similar matrix approach could be taken to reduce injuries from spearguns. Some speargun models come with a safety switch, which acts as a locking mechanism that prevents the trigger from being pressed accidentally. The speargun cannot be shot while the safety switch is on. Many spearguns will also not lock the shaft in place if the safety switch isn’t activated, further reducing the chances of an accident while loading it. However, not all spearguns have this safety feature and legislation regulating the sale of speargun models with a safety switch would be beneficial in reducing these injuries. People must also consider environmental aspects during spearfishing, which includes awareness regarding other dangers like free-diving risks of barotrauma, shallow water blackout, currents/drift and sharks or other marine life envenomation. While every injury cannot be prevented, implementation of the whole spectrum of prevention strategies may have a higher chance to successfully reduce incident rates.

Currently, there is no legislation in New Zealand regarding the use of spearguns, and users do not require a license even though they can cause injuries similar to those caused by firearms. While most firearm injuries are intentional, the majority of speargun injuries are unintentional. Hence, there is an increased need for legislation around firearms. After the 1996 gun law reforms in Australia, there has been an accelerated decline in total gun deaths, including firearm-related homicides and suicides. Considering the potential similarities of spearguns to firearm injuries, Australia has also introduced legislation regarding the use of spearguns under the Firearms Regulation. They have also included codes of practice for spearfishing to promote environmental, social, economic and safety criteria. In New Zealand, under section 92 of the Amendments to the Arms Act 1983, a health practitioner must notify the police if the health condition of their patient will impact on their own safety or public safety if they have access to the use of firearms. The police were not involved in our case, but if use of spearguns is included under the firearm regulation we may need to inform the police regarding these cases. Moreover, given the case reports of spearguns being used as a method of suicide, licensing requirements should also include that the owner of the gun should be of sound mind.
**Conclusion**

Spearguns can produce life-threatening injuries if discharged accidentally. Removal of the spear depends on whether the flapper is open and the location of the tip to adjacent structures, and requires a multidisciplinary team approach. There needs to be concentrated efforts to publish safety regulations and include the potential risks of speargun injuries in fishing rules. In view of the potential risk of life-threatening injuries, introducing a license requirement for the possession and handling of this firearm-like weapon needs to be considered.
COMPETING INTERESTS
Nil.

AUTHOR INFORMATION
Sohil Pothiawala: Fellow, Trauma & Emergency Services, Auckland City Hospital, Auckland.
Ian Civil: Director, Trauma Service, Auckland City Hospital, Auckland.

CORRESPONDING AUTHOR
Dr Sohil Pothiawala: Fellow, Trauma and Emergency Services, Auckland City Hospital, 2 Park Road, Grafton, Auckland 1023, New Zealand.
Ph: +64212281373. E: SohilP@adhb.govt.nz

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