CASE REPORT

# ABDOMINAL INJURY DUE TO A HAND HELD FLARE: AN ONGOING INSULT

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## Abstract

**Although traumatic abdominal missile injuries have been previously widely reported, there are no reports on penetrating hand held flare injuries. We report a case of a penetrating abdominal flare injury and the subsequent complications that occurred as a result of this unique injury.**

## Introduction

Traumatic abdominal missile injuries have been widely reported. Most of these reports describe bullet or shrapnel penetration. A penetrating abdominal hand held flare injury is a unique traumatic injury. We present a case of an accidental penetrating abdominal flare injury with particular focus on the protracted thermal and chemical damage this can cause. This type of injury has not been previously reported in the medical literature.

## Case Report

A 51 year old Royal Yachting Association instructor was demonstrating a marine safety flare, when it accidentally fired retrogradely, penetrating his abdomen. It entered the left side anteriorly, just above the level of the umbilicus and exited through the lumbar muscles in the lower left flank. He sustained significant intra-abdominal trauma, and presented to the Emergency department shocked, with a 10 cm defect in the anterior abdominal wall. Additionally, there were injuries to the right hand with a laceration on the thenar eminence and amputation at the distal phalanx of the right ring finger.

After initial resuscitation an emergency laparotomy was performed. The abdominal cavity was filled with black chemical debris and numerous injuries identified. The descending and transverse colon were lacerated with faecal contamination of the abdomen. There was an almost circumferential small bowel defect in the jejunum 10 cm from the duodenojejunal flexure and a splenic laceration. The Inferior Mesenteric artery was transected and there was significant degree of fat necrosis in the left paracolic gutter; the flare casing protruded through the left lumbar muscles.

He underwent large bowel resection from proximal transverse colon to the sigmoid colon with end colostomy in the right iliac fossa, splenectomy and primary closure of the jejunum after the edges were debrided. Additionally, there was extensive necrosis along the missile tract requiring debridement of the entry and exit wounds as well as the fat in the left paracolic gutter. Of note, there was no evidence of pancreatic injury at this stage and the serum amylase was 51u/l. The abdominal cavity was copiously washed out with saline. Perioperatively a massive blood transfusion was required.

Over the next 5 weeks he had a persistently raised white cell count and temperature up to 40°C. Multiple re-look laparotomies were performed with further debridement of necrosed and subsequently calcified fat comprising the whole of the greater omentum (Figure 1), fat in the left paracolic gutter, the splenic bed and Gerota's fascia. Parenteral nutrition and a laparostomy were required. Additionally, at the seventh laparotomy a distal pancreatectomy was performed due to necrosis. After five weeks, once all the necrotic fat was excised, the pyrexia settled.

*Figure 1. Calcification and Necrosis affecting the Greater Omentum.*

Subsequent laparotomies were required for intestinal failure with dense fibrosis affecting the small bowel ultimately requiring resection of 60 cm of jejunum and proximal ileum.

As the laparostomy granulated over the next few weeks, enterocutaneous fistulae developed which were initially managed conservatively and finally closed surgically.

In total, the patient required 12 weeks on the high dependency unit, 8 months in hospital and a total of 16 operations. He was eventually discharged home on a normal diet and has subsequently progressed well.

## Discussion

Hand held flare injuries are an unusual injury either in war or peace time. There are isolated case reports describing devastating injuries to the face and thorax though there are no reports of penetrating abdominal injury [1,2]. The three components described are the direct damage caused by the missile, thermal

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injury and finally the chemical injury. All of these components add up to a far more significant injury than initial appearances may suggest [1].

The chemical injury and duration of thermal injury are unique to an explosive flare injury and do not take place in other penetrating missile injuries. The Pains Wessex Mk 7 white handheld collision warning flare burns at 3,000°C for 60 seconds; its chemical content is designed for controlled combustion producing a white flame and smoke (Table 1). The combination of oxidizers, fuel, propellants and coloring agents produce glowing solids and a vast volume of hot gases [3]; it has since been recalled by the manufacturer following this incident.

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| **Pre-combustion contents** | Magnesium Metal<br>Strontium Nitrate<br>Ellisprene<br>Potassium Nitrate<br>Potassium Perchlorate<br>Poly Vinyl Chloride<br>Boiled Linseed Oil<br>Di-Butyl Phthalate<br>Gunpowder |
| **Products of combustion** | Salts of potassium and strontium<br>Oxides of magnesium<br>Carbon dioxide and carbon monoxide. |

*Table 1. Chemical Constituents of the Pains Wessex MK7 Handflare.*

Several of the chemical components, in particular potassium nitrate, are an irritant to human tissue and in the long-term, potentially hazardous. Potassium Perchlorate may have long term effects on thyroid hormone production by interfering with iodine metabolism. In case of accidental contamination all clothing should be removed and exposed areas washed with water for at least ten minutes [4].

The exact nature of the chemical injury in this case is debatable as a result of the pancreatic injury, which may have contributed to the ongoing systemic inflammatory response syndrome (SIRS), calcification and fat necrosis. The abdominal fluid was not assayed for amylase and as a consequence the degree to which pancreatitis played a part in this process is unknown. However, the early detection of necrosis and calcification, as early as the first laparotomy, is highly suggestive of a relationship to the chemical inoculum.

It is often the case with high energy transfer penetrating abdominal injuries that multiple organs are damaged and an early damage control approach in such cases should be considered. Resection and end colostomy was performed in this case due to coagulopathy and haemodynamic instability, however in a more stable patient with a lower trauma burden primary anastomosis should be considered. Primary anastomosis does not adversely influence patient outcome in comparison to stoma formation however severe fecal contamination, transfusion of more than 4 units of blood within the first 24 hrs and single agent antibiotic prophylaxis were found to be independent risk factors for abdominal complications in a prospective study of 297 patients undergoing colonic resection for penetrating trauma [5]. Penetrating splenic injury in this context probably mandates splenectomy though there is a clear case for splenic preservation in a stable patient [6].

Penetrating injury to well vascularised small bowel can reasonably be anastomosed though in this case there was progressive fibrosis of the small bowel leading to gut failure with consequent anastomotic leakage and fistulation. We believe that the most likely cause of the fibrosis was the continued chemical effect of the flare components on the intestine. Although conservative management of the gut failure and fistulation was instituted for several months, small bowel resection and anastomosis was eventually required.

## Conclusion

This case has highlighted the potential effects of a flare gun injury penetrating the abdominal cavity. Progressive intra-abdominal fat necrosis and small bowel fibrosis from both the thermal and chemical components were the hallmark of this injury.

## References


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