

Case Report

Chest wall reconstruction following a speedboat propeller injury

D. Sladden, A. Casha, A. Manché

Abstract

Propeller blade injuries to the chest are uncommon but can result in devastating injuries. We describe a case of a 44 year-old male scuba diver who was dragged by sea currents into the propeller of a speedboat. He suffered extensive chest wall trauma but narrowly escaped damage to major organs and vessels. He was admitted directly to the operating theatre. There was significant loss of bone from the manubrium, costal cartilages, overlying skin and muscle which were stripped off in 3 horizontal bands. During reconstruction the bony fragments were anchored to the nearest stable sternal or costal cartilage entities using steel wires, to achieve stability. The overlying muscle and skin were sutured directly to its opposite edge in layers and in an interdigitating fashion following the shape of the propeller blade lacerations. The patient remained intubated for 3 days in ITU and was transported back to his home country. He required a small skin graft to one area of necrosis but eventually made a full recovery with only his scars as a reminder of his accident. There have been other cases of propeller injuries in Malta but this is unique in being a severe injury to the chest, in which the patient made a full recovery. This report highlights the importance of legislation in preventing propeller injuries by restricting swimmer zones and introducing propeller guards or jet drive systems.

Introduction

Propeller injuries are massively debilitating injuries with high mortality and account for 3.8% of all boating injuries in the US. In an average year there were 200-250 reported non-fatal propeller strike injuries¹. Another 25-35 (12%) cases a year are fatal.¹ Such statistics may be under-reported by around 20%.² 72% of propeller injuries were the second or third event in an accident, the prior events being falling overboard or being hit by the boat itself prior to the propeller strike.

It is written in US federal law that all boating accidents involving the death or injury requiring medical attention of a person must be reported to the US coast guard and will be made available in public records⁴. No such records exist in Malta.

In a Canadian study 9 of 112 cases of propeller injury involved the chest and 2 of those 9 (22%) died. This is the second highest mortality classified anatomically after propeller injuries of the head, which are fatal in 40% of cases. The severity of propeller lacerations is such that several cases of complete limb amputation are described. Of the non-fatal chest injuries pneumothorax and lung contusions were the most common.³

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A 44 year-old male on holiday in Malta was scuba-diving off Comino one August morning. While surfacing he experienced strong currents which pushed him into the moving propeller of his boat, which was not at maximal speed. The diver ascended into the propeller suffering injuries on the anterior aspect of his chest. His diving colleagues hoisted him onto the same boat and hastily made their way back to shore.

A member of his diving team was a cardiothoracic surgeon and provided first aid, covering the wound with a beach towel.

He was immediately taken to casualty by ambulance. On arrival he was conscious and breathing spontaneously. Analgesia was administered and he was intubated and ventilated and invasive arterial blood pressure monitoring was set up. Intravenous fluids were given until blood was typed and screened. At that stage he was haemodynamically stable.

The wounds were inspected and the right lung was visible protruding through the defect in the anterior chest wall. The wounds were covered with sterile large swabs

David Sladden MD, MRCS, MSc(Surg)*

Department of cardiac services
Mater Dei Hospital
Msida, Malta
david.sladden@gov.mt

Aaron Casha MPhil, FRCS(CTh), FETCS.

Department of Cardiac Services
Mater Dei Hospital
Msida, Malta

Alexander Manché MPhil, FRSC(CTh), FETCS

Department of Cardiac Services
Mater Dei Hospital
Msida, Malta

*Corresponding author

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and the patient was taken directly to the operating theatre.

Figure 1: The injuries upon arrival to casualty. The white swab in the right side of the larger wound is covering herniating lung



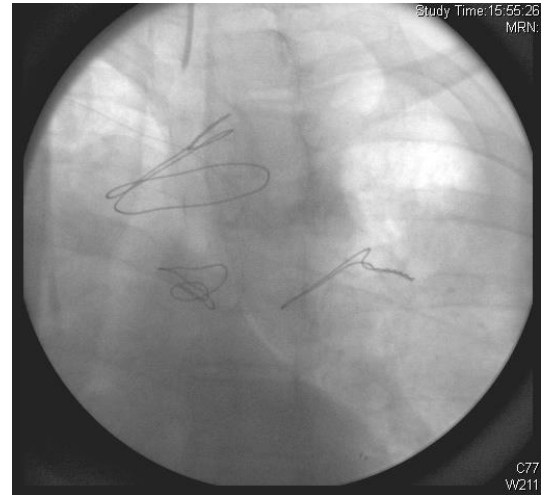
In theatre the wounds were cleaned from debris and sand. The chest was inspected and the lacerations were found to stop just short of the aortic arch and the brachiocephalic artery and vein in the superior mediastinum. Both lung apices were exposed and lung tissue was contused bilaterally but not lacerated. The pericardium was intact and no cardiac trauma was detected through the exposed anterior mediastinum.

The lower two horizontal musculo-cutaneous wounds were sutured in two layers as no deep structures were involved. The suturing was performed in an interdigitating fashion so as to match the edges of the wounds together. The shape of the propeller blades results in lacerations which are not straight but curved downward at one end and producing a zigzag configuration.

The superior wound was by far the larger and the damage involved the sternum and the upper costal cartilages. A portion of the manubrium was missing, leaving a defect slightly to the right of the midline. The sternum was separated with loss of the second and third costal cartilages on the left and the third and fourth costal cartilages on the right, also with some defect present due to tissue loss.

Stainless steel wires were used to anchor the detached middle sternum to the corresponding medial ends of ribs and clavicles bilaterally. The remaining upper sternum and manubrium was wired to the medial ends of the upper two right ribs. This defect was not closed as the edges could not be opposed. The gap was bridged by the wires, which stabilised the upper chest wall.

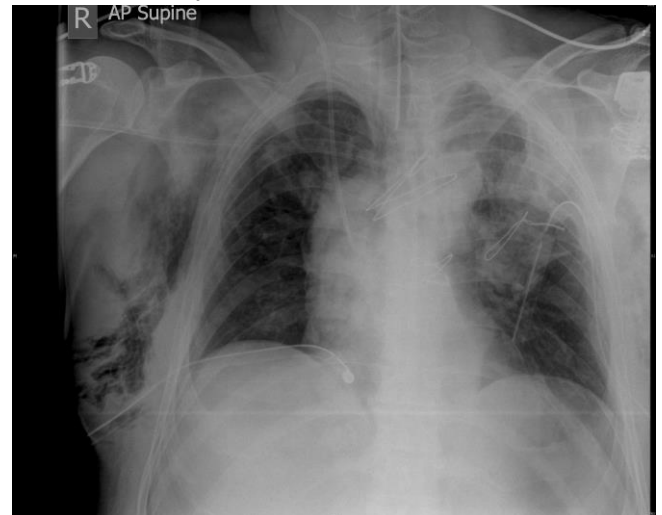
Figure 2: Post-operative chest x-ray showing the position of the steel wires



The overlying muscle was used to bridge defects in the ribcage, and was sutured with multiple single absorbable braided sutures and a subcuticular suture helped approximate the gaping wound. All skin closure was achieved using interrupted non-absorbable sutures. Bilateral wide calibre chest drains were inserted and the patient was transferred to the Intensive Care Unit where he was kept intubated.

The chest drains continued to bubble initially but this soon resolved and there was no persistent air leak. Despite bilateral lung contusions he maintained good oxygenation and was fit for extubation on the second day.

Figure 3: A chest x-ray on day 1 post-op showing surgical emphysema on the right, lung contusion on the left and 2 chest drains in situ



Extubation was however delayed as arrangements were made by the family for air-ambulance transfer back home. Once in his home country he was extubated within 48 hours and made a good recovery. He required a small skin graft to an area of skin necrosis in between the top and middle lacerations. At 3 months after the

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injury he is returning back to a normal life and feels well.

Figure 4: photograph after 3 months. Note the diamond shaped area where the skin graft lies



Figure 5: photograph after 3 months from left side with arms raised



Discussion

Malta's pre-hospital policy is that of scoop and run, with the aim of getting the patient to hospital as quickly as possible. A consultant emergency physician meets the patient at the site of the accident and begins procedures such as IV access and analgesia in transit.

Once in the resuscitation room a team-based approach following the European Trauma Course guidelines is followed. A quick overall survey is performed to identify any other occult and life-threatening injuries. The cardiothoracic surgery team were involved from the start of the resuscitation. The main surgical technique is that of damage control surgery. It involves the rapid control of haemorrhage and contamination in order to allow a survivable physiology to be established. In this case no major organs had been severely damaged and so a one-stage reconstructive

surgical procedure was performed. There are circumstances where delayed closure is advised, either to allow for eventual swelling or to limit operation time or to allow for continuous drainage of a contaminated wound. In this case the wound was contaminated however primary closure was still performed. This is because the chest cavity was opened and the lungs were protruding through the wound. This would have led to further problems since the patient was receiving positive pressure ventilation post-operatively.

Post-operatively the patient was covered with broad spectrum antibiotics because of the grossly contaminated wounds and the risk of pneumonia following lung contusions and intubation. Other preventative measures included the use of low tidal volumes to avoid barotrauma and adult respiratory distress syndrome (ARDS). The chest mechanics and stability were unpredictable and we were concerned about post-operative wound dehiscence on coughing. This did not occur and the chest remained intact.

In Malta there are 45 designated swimming zones where the use of propeller motors is not permitted⁶. There is no regulation on the imposition of propeller safety guards and neither is there a public registry of recreational boating injuries. Despite this lack of formal data most of these incidents are news items and a search of local newspaper online archives revealed other cases of propeller injuries.

In August 2012 a 44 year-old male was found dead on a reef with propeller injuries to the head cited as the cause of death⁷. Only 12 days before the case reported here, a 24 year-old swimmer suffered lacerations of both feet after being hit by a boat propeller. In 2008 a German holidaymaker was hit by a propeller causing transection of his brachial artery amongst other injuries.

Conclusion

With water sports becoming ever more popular and the increasing number of holidaymakers in Malta, it is surprising that these accidents are not more common.

As shown, these cases are amenable to primary closure and this patient made a full recovery after one surgical repair. However propeller injuries can be devastating and their prevention is as important an issue as their treatment.

These injuries are not medically preventable but should still be safeguarded by public health legislation and boat design. There are many different suggestions to improve propeller safety, such as safety propellers with non-sharp edges, tunnelled drives where the propeller sits in a hollow part of the hull, sensors to stop the propeller when someone approaches, jet drives and propeller guards. The jet drives and propeller guards are the most often used, however jet drives are unable to power heavier craft and propeller guards have not been made obligatory due to a variety of objections. For

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instance cage guards reduce efficiency and increase fuel consumption as well as the risk of debris getting caught in the cage and ring guards add the risk of getting trapped between the ring and the propeller and suffering worse injuries, besides reducing manoeuvrability.⁵

The size of the problem is unknown in Malta and a public registry needs to be made available in an effort to reduce these accidents.

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