CASE REPORT

Perioperative anaesthetic management of penetrating neck injury associated with Rh blood type in a young adult

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SUMMARY

We describe here a young adult patient with penetrating neck injuries (PNI) with an Rh negative blood type and discuss the perioperative anaesthetic management of single-stage surgical exploration under general anaesthesia and extracorporeal circulation in this patient. The patient had zone II PNI and he was in a haemodynamically progressive unstable state, and the knife penetrated the left internal jugular vein, superior thyroid artery and recurrent laryngeal nerve; the trachea and the oesophagus were swelling at a rapid rate. Eight weeks after operation, the patient was discharged from the hospital without any complications.

BACKGROUND

Penetrating neck injuries (PNI) can be a life-threatening event with vascular lesions and airway compromise, usually requiring emergency surgical treatment. Though there are reported differences, the mortality rates from such injuries range from 3 to 6% owing to injuries of the major vessels.¹ Owing to the anatomical complexity of the neck region, managing these patients is very difficult and dangerous for both surgeons and anaesthesiologists. The choice of treatment for a stable patient remains controversial: a number of retrospective studies encourage mandatory surgical exploration and a like number encourages selective surgical attention. And the optimal approach to airway management in PNI also remains a controversial topic with a paucity of literature. Additionally, the Rh blood group system is the most polymorphic of the human blood groups, consisting of at least 45 independent antigens, and is second to the ABO blood group as the most clinically significant in transfusion medicine.

We report an unusual case of a PNI by a knife with the knife still stuck in the neck and the patient with Rh negative blood type is a rare blood group typing. The patient underwent surgical exploration under general anaesthesia and extracorporeal circulation.

CASE PRESENTATION

A 17-year-old man (height: 171.5 cm, body weight: 65 kg) visited our emergency department with a knife stuck in his neck because of a fight with someone for little trifles.

Upon initial examination, the patient was conscious and distressed, and haemodynamically stable. But he had intermittent cough with

blood-tinged sputum, neck swelling, air bubbling through the wound and dyspnoea. A local examination revealed a 30 mm left anterior neck wound in zone II identified (figure 1)² in the site of injury was defined as the area between the cricoid and the inferior border of the thyroid cartilage, and the direction of the wound towards the midline (figure 2). Though the knife was still embedded on his neck and did not cause an exit wound, there was active bleeding. Peripheral pulses were palpable over the carotid arteries and in the upper limbs. He was found to have an unusual AB blood type of Rh negative. Other laboratory findings, including a complete blood count, electrolytes and glucose, were all within the normal limits.

He was treated initially with oxygen by nasal cannulae and intravenous normal saline and colloidal solutions. Neck radiographs were obtained which demonstrated that the knife was embedded on the sixth cervical vertebral body. Since the patient was irritable and uncooperative, radiographic evaluation by cervical CT and x-ray was poor for the penetrated neck. Midazolam 2–3 mg was administered for sedation, but there was no effect. A fiberoptic bronchoscope could not be performed, because there was possibility of tracheal laceration, and intubation could worsen this. So, we decided to explore the neck and trachea under general anaesthesia and thus transferred the patient to the operating room.

In the operating room too, the patient was irritable and uncooperative. At the time of admission, standard monitoring (ECG, pulse oximeter) was applied, and oxygen was supplied through a face-mask. Heart rate, blood pressure and oxygen saturation were 128/min and 90/40 mm Hg and 96%, respectively. And arterial blood gases displayed pH 7.00, PaCO₂ 10.60 kPa, PaO₂ 5.60 kPa, HCO₃⁻ 18.5 mmol/l, BE-11.3 mmol/l, haematocrit 23% and haemoglobin 7.8 g/dl. Immediate surgical exploration was arranged by the on-call general surgeon, and carried out under general anaesthesia. A central venous catheter was inserted in the right femoral vein and arterial pressure was measured directly from the left radial artery with a 51 mm, 20-gauge arterial cannula attached to the arterial tube.

The surgery was started after 1% lidocaine infiltration over the skin and subcutaneous tissue for local anaesthesia. In this patient who underwent airway management, the airway was secured by performing transoral flexible fiberoptic bronchoscope intubation at an emergency medical centre and by

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Figure 1 Three-dimensional volume-rendered image from multidetector CT angiography shows the three anatomic zones of the neck (from Steenburg, *et al*²). A 30 mm left anterior neck wound in zone II was identified, the site of injury was defined as the area between the cricoid and the inferior border of the thyroid cartilage.

subsequently converting to tracheostomy in the operating room. Fortunately, there was no visible tracheal injury upon the bronchoscopic examination. Then we performed the tracheostomy and started with general anaesthesia. He was connected to a cardiopulmonary bypass (CPB) using a completely heparin-coated system with an access via the left femoral vein and artery. During CPB the coagulatory status was checked every 15 min with a targeted anticoagulation time between 250 and 300 s. Intraoperative blood salvage and retransfusion were carried out during CPB to reduce perioperative blood loss. The CPB was initiated after surgery for almost 50 min. Surgical exploration revealed that the sternomastoid and strap muscles had been severed, and the left internal jugular vein was ruptured. The

Figure 2 The direction (red arrow) of the wound towards the midline.

patient required 6 units of homologous blood (AB blood type of Rh positive) and 1100 ml of autologous blood reinfusion during the operation and remained cardiovascularly stable, apart from one episode of bradycardia that responded to atropine. The knife was removed by the surgeon with careful observation of the vessels, thyroid gland, trachea and oesophagus. After the termination of CPB, infusion rates of inotropic and vasoconstrictor drugs were set according to the patient's circulatory state. A mean arterial pressure of 60 mm Hg or greater were the targets. The total operation time was 220 min. After weaning off the CPB, heparin was antagonised with protamine sulfate in a 1:1 ratio.

INVESTIGATIONS

Penetrating neck injuries (PNI) can be a life-threatening event usually requiring emergency surgical treatment, with vascular lesions and airway compromise. Though there are reported differences, the mortality rates from such injuries range from 3% to 6% owing to injuries of the major vessels. However, little is known about the perioperative anaesthetic management of PNI associated with Rh-negative blood type.

DIFFERENTIAL DIAGNOSIS

The cricoid cartilage was split on the left, and partial laceration of the trachea and the oesophageal transection was observed. The superior thyroid artery was ruptured and there was a recurrent laryngeal nerve injury on the left.

TREATMENT

The internal jugular veins and superior thyroid artery were ligated, haemostasis was secured, the cricoid cartilage, trachea and oesophagus were sutured, end-to-end anastomosis of the recurrent laryngeal nerve was performed, the strap muscles were repaired and the cervical fascia closed around the sternomastoid that was loosely approximated.

OUTCOME AND FOLLOW-UP

At the end of the surgery, a Yates drain was placed and the patient was admitted to the intensive care unit for close observation. He remained intubated until day 7, by day 8 the patient was transferred to the surgical ward, the endotracheal tube was removed with good self-respiration on the 16th postoperative day, and he was discharged home on day 48. At 7 weeks follow-up, in the case presented at the site of tracheostomy in the neck developed a tracheoesophageal fistula. A conservative approach was adopted and a gastrostomy tube was placed for drainage and a separate jejunostomy tube for nutrition; the tracheoesophageal fistulas had a successful occlusion. After 8 weeks of operation, the patient was discharged from the hospital without any complication.

DISCUSSION

Civilian trauma is increasing worldwide as a cause of death among young individuals and is reflected in the apparent increase in the frequency of penetrating vascular injuries of the neck. PNI are infrequent but can result in significant morbidity and mortality, mainly owing to major vascular injuries. The most common aetiologies of PNI are stab wounds, gunshot wounds or shotgun wounds.³ The anatomy of the neck is complex, and many vital structures (vascular, laryngotracheal or oesophageal) reside in close proximity, sometimes within millimetres, to one another. Appropriate, rapid management is critical to improve the outcomes.

The neck is divided into three horizontal anatomic zones (zones I, II and III). Zone II, which extends from the level of the cricoid cartilage to the angle of the mandible, is the largest and the most commonly injured zone in PNI.^{4–5} Zone I and III injuries are difficult to evaluate and surgically manage⁵ and therefore should likely be managed in a trauma centre. Transfer to a trauma centre for surgical intervention is indicated for unstable patients with PNI and patients with signs of major vascular or airway injuries.^{4–6} In contrast, the management of stable patients with PNI is controversial, particularly in rural areas with limited or no surgical backup. The areas of debate include the accuracy of the physical examination in detecting major injuries, wherein imaging modalities can be used to identify occult injuries in stable patients, and whether all patients with PNI should be transferred to a trauma centre for diagnostic imaging or surgical assessment and exploration.⁷

The initial management of PNI follows standard trauma resuscitation principles, including immediate airway control with early endotracheal intubation, cricothyroidotomy or tracheostomy for actual or impending airway compromise. PNI are challenging in their complexity and in their initial resuscitation, particularly in terms of optimal airway management. Approaches to management did not follow a set universal protocol, but instead were tailored to the individual patient's presentation and/or the skills and comfort level of the provider. We believe that a careful, planned intubation under fibre-optic guidance would be a prudent approach adopted in this case. Assessment is made for an evidence of vascular, airway and respiratory, neurological, oesophageal, skeletal and soft tissue injuries that may be seen in descending order of frequency.⁸ Definitive care includes immediate surgery for unstable patients or those presenting with clinical findings that suggest significant injury.

It is generally understood that the Rh and the ABO blood group systems are entirely independent of each other. The discovery of the Rh blood factor in humans in 1940 and in 1941, its important relation to erythroblastosis foetalis, once again focused attention on this disorder. The Rh blood factor is present in the red cells of 85% of the white population and absent in 15%. Since it is foreign to the system of the latter group, the Rh factor can act antigenically to start isoimmunisation, when introduced into the body, either by transfusion or, in women, and even then only in a small percentage of them, during pregnancy. The antibodies produced by the Rh-negative individual, after sensitisation, are agglutinins, capable of clumping and eventually destroying Rh-positive red cells. It usually requires one or more transfusions of Rh-positive blood into an Rh-negative patient, and an interval of 2 weeks or more, before a haemolytic reaction is produced. Clinical observations found that using compatible blood for transfusion, repeated small transfusions of Rh-negative blood and the best care of the newborn infant with haemolytic disease may solve the problems of the management of blood incompatibility and antibody action.⁹ The Rh blood group system is the most polymorphic of the human blood groups, consisting of at least 45 independent antigens, and is second to ABO blood group as the most clinically significant in transfusion medicine.¹⁰ The RhD, RhC and RhE proteins are the RH gene product and the component in the Rh blood group system carries the strongest blood group immunogen, the D, C and E antigens. Studies suggested that the risk of haemolytic disease of the newborn is because of the presence of anti-D, anti-D+C, or anti-D+C+E

alloantibodies in RhD-negative pregnancies.¹¹ In addition, WinRho has been shown to be a pure, safe and effective preparation for preventing Rh alloimmunisation. Therefore, a sensitised Rh-negative patient might suffer a fatal haemolytic transfusion reaction just as well if blood of the incorrect blood group is transfused, as if Rh positive homologous blood is given. However, in one study on 11 Rh-negative volunteers of blood donors, 8 were given doses of 0.01 ml and 3 were given doses of 0.1 ml on each occasion, 7 volunteers developed Rh antibodies, 1 was doubtfully immunised, and in 3 people, Rh antibodies could not be demonstrated, and in these non-responders, even increased booster doses appeared to have no effect.¹² In this case, we found that the transfusion of this Rh-negative man with Rh-positive blood has not lead to a haemolytic crisis or the antibody response. It may be associated with the long survival of the Rh-positive cells in an Rh-negative recipient whose blood does not contain antibodies against the immunising cells or tolerance rather than the production of antibodies.

Transfusion reactions occur in 6–20% of cases.^{13–14} Although the majority are febrile reactions and allergic responses are rarely serious, haemolytic reactions owing to ABO and Rh incompatibility occur in 0.01% of transfusions, and these are potentially fatal.¹⁵ Various blood conservation techniques can reduce exposure to allogeneic blood. These include preoperative autologous blood donation, acute normovolaemic haemodilution and intraoperative blood salvage. Autologous blood may be collected in several ways.

It is well known that CPB management in an open heart surgery often requires the use of mechanical circulatory assist devices (MCADs). MCADs are also utilised to harvest, preserve and reinfuse autologous blood in the management of heart and major vascular surgeries. Autologous whole blood reinfusion appears to be significantly related to increased haemoglobin, haematocrit, platelet count, fibrinogen, plasminogen and antiplasmin levels.¹⁶ Autologous whole blood may be collected by CPB and can maximally preserve the platelets and reduce the requirements of packed erythrocyte transfusion,¹⁷ and decrease transfusion-related infection and the patient's hospital bill.

In this case, the patient had zone II PNI and he was in a haemodynamically progressively unstable state, with the knife penetrating the left internal jugular vein, superior thyroid artery and recurrent laryngeal nerve, the trachea and oesophagus were swelling at a rapid velocity. So, the management of our case was consistent with current clinical guidelines.⁶

Simultaneously, intraoperative autologous blood salvage, preservation and retransfusion were carried out during CPB to reduce perioperative blood loss and the risk of homologous blood transfusion.

Although rare, combined injuries of the trachea and oesophagus from PNI can be difficult to diagnose, and delayed diagnosis and treatment result in increased morbidity and mortality.

Transfer to a trauma centre for surgical intervention is indicated for unstable patients with PNI and patients with signs of major vascular or airway injuries. This patient exhibited severe symptoms of airway injury (haemoptysis, hoarseness and neck swelling) and symptoms suggestive of a digestive injury (dysphagia, odynophagia, or haematemesis) require surgical intervention. Additionally, preoperative evaluation and the tracheostomy tube by fiberoptic bronchoscope under local anaesthesia were deemed most appropriate.

Learning points

- ▶ The diagnosis and treatment of penetrating injuries of the neck.
- ▶ The question of evaluating various series of cases is made complicated by several mechanisms of injury as drawn from different cultures and environments.
- ▶ Intraoperative autologous blood salvage, preservation and retransfusion were used during cardiopulmonary bypass to reduce perioperative blood loss and the risk of homologous blood transfusion.
- ▶ The Rh and the ABO blood group systems are entirely independent of each other.

Competing interests None.

Patient consent Obtained.

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