

The use of ultrasonography in the perioperative management of penetrating chest trauma with indwelling blade

S Kudsk-Iversen^a and R Matos-Puig^{a*}

^aStanger Hospital, Stanger, South Africa

*Corresponding author, email: roelmatos@hotmail.com

We report on the anaesthetic and postoperative analgesic management of a patient presenting with a single penetrating thoracic injury, with radiological confirmation of a foreign object still present in the thorax. The patient underwent an emergency right posterolateral thoracotomy. We discuss the use of ultrasound for the insertion of a paravertebral catheter for perioperative analgesic management, and its efficacy in the emergency setting. Furthermore, we discuss the use of perioperative focus assessed transthoracic echocardiography, which had a positive impact on our management, although the case highlights the need for further large multi-centre trials.

Keywords: focus assessed transthoracic echocardiography (FATE), paravertebral block, penetrating thoracic injury, thoracotomy, ultrasound-guided regional anaesthesia

Case study

A 25-year-old male, with an estimated weight of 80 kg, presented to the emergency department with a history of a stab injury to the right side of the chest. He did not have a previous medical history. He was haemodynamically stable (Table 1) with no respiratory distress, and the only apparent injury was a 3 cm laceration across the right anterior chest wall. The chest radiograph showed a 10 cm object with increased radiopacity (Figure 1), and a lateral chest X-ray confirmed an image consistent with the blade of a knife still within the thorax (Figure 2). Except for the object and the minimal blunting of the costophrenic angle on the right, the chest X-ray was normal, with no evidence of any major haemopneumothorax. Full blood count (haemoglobin 14.3 g/dl), electrolytes, renal function and international normalised ratio were all within normal limits, and the electrocardiogram showed a normal sinus rhythm with no acute abnormalities.

Twelve hours following his presentation, the patient was brought to the operating theatre for a right posterolateral thoracotomy for the removal of the foreign object and the exploration of any potential associated injury. Based on the surgical assessment of the position of the foreign object, the surgeons stated that there was no anticipated need for single-lung ventilation. The patient's vital measurements are presented in Table 1.

Basic focus assessed transthoracic echocardiography was performed in theatre before induction, and a right pneumothorax and minimal fluid in the right pleural space were noted. The rest of the scan was unremarkable, with the inferior vena cava (IVC) diameter showing no variation with respiration.

The right radial artery was cannulated for invasive blood pressure (BP) monitoring.

A rapid sequence induction was performed using fentanyl 200 µg and dexamethasone 8 mg, both given three minutes before administration of propofol 200 mg and suxamethonium chloride 100 mg.

There was an immediate drop in BP and heart rate (a 49.4% decrease in mean arterial pressure from 107–54 mmHg, a 46.7% decrease in systolic BP from 154/83–82/40 mmHg, and a 20% decrease in heart rate from 107–86 beats/minute following induction. Noticeable distensibility of the IVC in response to mechanical ventilation, suggestive of fluid responsiveness, was shown following a further sonographic review at this point. Rapid 500 ml fluid bolus restored the BP.

While the endotracheal tube was being placed, the surgical team placed an intercostal drain on the right side. After induction, the patient was placed in the left lateral decubitus position. An epidural catheter was placed under sonographic guidance in the fifth right paravertebral space and a bolus of 20 ml of 0.25% bupivacaine was administered.

The patient was placed on volume-controlled ventilation [positive end-expiratory pressure 5 cmH₂O, tidal volume 400 ml, respiratory rate of 12 breaths per minute, fraction of inspired oxygen 2 (FIO₂) 0.60, end-tidal carbon dioxide 43 mmHg (average)]. Peak and plateau airway pressure were both consistently below 25 cmH₂O. Morphine (3 mg), ketamine (40 mg), and diclofenac (75 mg intramuscularly) were additional analgesia administered intraoperatively at the end of the operation. The oxygen saturation remained above 97% throughout the operation.

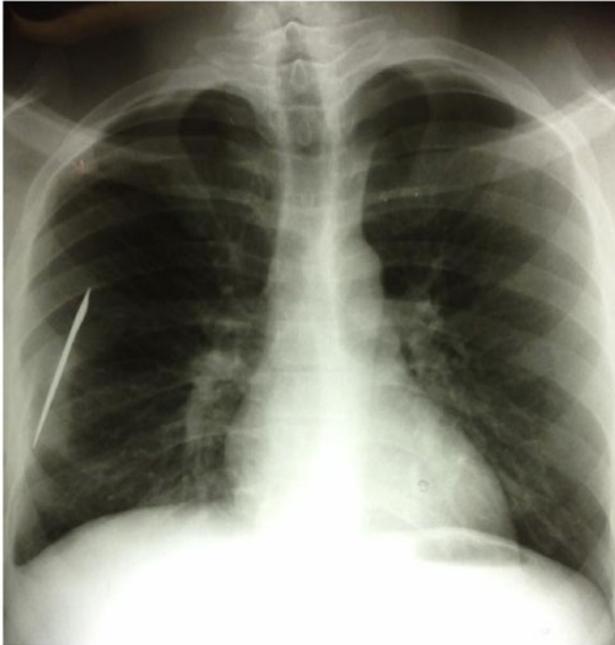
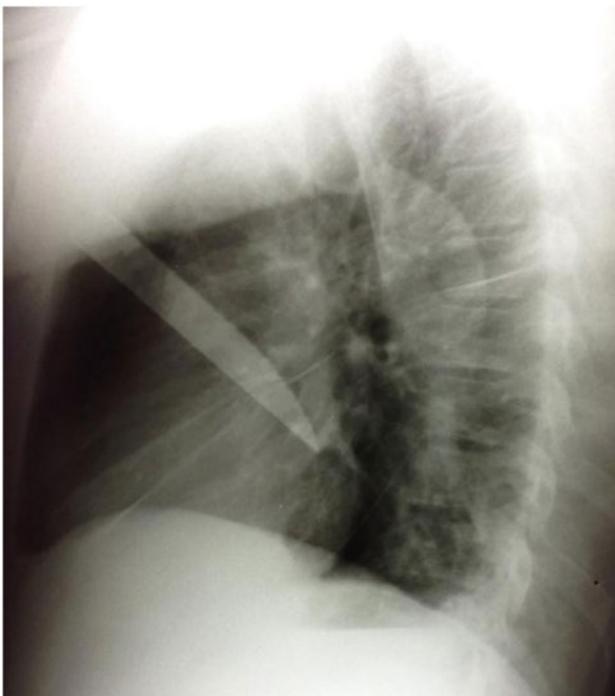
The surgical procedure lasted 1.5 hours. It was uncomplicated, with no lung collapse, and besides removal of the 10 cm knife blade (Figures 3 and 4), a minor perforation of the right upper lobe of the lung with leakage of air was found. An additional apical intercostal drain was placed, and postoperatively the chest X-ray was commensurate with someone having undergone a right-sided thoracotomy (Figure 5). Total blood loss for the operation was approximately 500 ml.

The patient was extubated on the table (Glasgow Coma Scale 15/15), with no complaints of pain. Thereafter, he was transferred to the intensive care unit (ICU) for close monitoring and postoperative analgesic optimisation. An arterial blood gas was

Table 1: The patient's vital measurements, recorded at key times

Vital measurements	On presentation	Immediately preoperatively	Immediately postoperatively	On discharge from the ICU
Respiratory rate (breaths/minute)	20	18	23	26
Oxygen saturation (FiO ₂)	95% (room air)	98% (0.59)	98% (0.40)	98% (0.40)
Heart rate (beats/minute)	98	107	61	61
Blood pressure (mmHg)	122/77	154/83	170/80	140/74
GCS	15/15	15/15	15/15	15/15

FiO₂: fraction of inspired oxygen 2, GCS: Glasgow Coma Scale, ICU: intensive care unit

**Figure 1:** Anterior-posterior chest X-ray prior to surgery**Figure 2:** Lateral chest X-ray prior to surgery**Figure 3:** The surgical field (seen from the patient's head end)**Figure 4:** The blade after removal

carried out 30 minutes postoperatively (FiO₂ 0.40). It showed pH 7.37, partial pressure of carbon dioxide 5.7 kPa, partial pressure of oxygen 9.9 kPa, serum bicarbonate 24.4 mmol/l with haemoglobin of 13.9 g/dl, lactate of 1.1 mmol/l and an oxygen saturation of 94%. The patient received full oral nutrition from the time of arrival to ICU.



Figure 5: Posterior-anterior chest X-ray after surgery

Oral paracetamol (1 g every six hours) and tramadol (50 mg every six hours) was the baseline analgesia that was prescribed. Analgesia was further maintained by paravertebral administration of 20 ml of 0.25% bupivacaine upon the request of the patient (approximately every 12 hours). The patient remained on supplemental oxygen via a 40% Venturi® face mask. He was subsequently discharged from ICU three days following surgery, with no complaints of pain. The paravertebral catheter was removed immediately prior to his discharge from ICU. He was finally discharged from hospital eight days after presentation.

Discussion

Thoracic epidural has long been considered to be the ideal postoperative mode of analgesia for a thoracotomy.¹ The paravertebral block is increasingly being used, because of its simpler technique and lower risk of complications when compared with an epidural.^{2,3} There is increasing evidence to support the use of a paravertebral blockade in elective surgical cases, as it has been reported it to be as effective as neuroaxial analgesia.^{3,4} Additionally, the use of a paravertebral catheter for postoperative pain management has been found to be as effective as a thoracic epidural, and may also reduce the length of hospital stay significantly.⁵ Finally, the use of ultrasound for the placement of the catheter is likely to reduce complications associated with regional blocks, increase the success rate of efficient analgesia and reduce operator time, although more research comparing blind, with an ultrasound-guided, technique, is warranted.⁶ Our case demonstrates that it was possible to achieve effective analgesia in a patient undergoing an emergency thoracotomy using a paravertebral catheter placed under ultrasound guidance without negatively impacting on the operating time or postoperative management.

The use of perioperative sonography is not new, although the interest and evidence surrounding different techniques and protocols has gathered momentum in recent years.⁷ Indeed, as part of routine practice in both the pre- and intraoperative assessment of haemodynamics, it has been shown that ultrasonography can actively influence management in up to

75% of emergency cases.⁸ Assessing the IVC to determine fluid responsiveness is increasingly being used,^{9,10} although recent evidence brings into question how reliable it is in spontaneous and assisted ventilation.^{11,12} In our case, the change in IVC distensibility was seen following a dramatic change in circumstances, which can affect the overall haemodynamics of the patient, as well as intrathoracic pressure, i.e. rapid sequence induction, commencement of the mechanical ventilation and placement of an intrathoracic drain. The BP recovered rapidly following immediate administration of a crystalloid bolus. Thus, there are two key questions: Was the assessment of the IVC in the awake spontaneously breathing patient an accurate predictor of fluid status? Was he actually normovolaemic at the first assessment? There were confounders such as a new-onset pneumothorax and possibly restricted spontaneous tidal volumes. Secondly, was the drop in BP actually due to the cardiovascular impact of the anaesthetic induction agents? If the latter is the case, then the perioperative IVC measurements might cause confusion by suggesting a fluid responsive state, when in fact the hypotension should have been remedied by vasoconstrictors.

Conclusion

Despite the severity and anatomical location of the surgical procedure, the ultrasound-guided placement of a paravertebral catheter for the provision of targeted regional analgesia was successful and without complications. This adds to available data in favour of ultrasound-guided regional anaesthesia, and we encourage its application in the emergency setting.

Intraoperatively, the use of point-of-care ultrasonography provided us insight into the haemodynamic changes and guided our subsequent management. In a time of increasing interest in this field, more research is needed to fully validate and perfect these protocols in the perioperative setting.

Declaration — Full informed consent was obtained from the patient with regard to publication.

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