The patient remained relatively stable throughout her laparotomy with no haemodynamic deterioration. Laparotomy failed to provide a definitive cause for her cardiovascular instability although there were some clues. Haemoglobin concentration did not decrease and increased pressure on the IVC and congested hepatic and portal veins were noted. After surgery, the patient became increasingly shocked despite persistent administration of fluids and was extremely ill when she was transferred to intensive care.

Pigtail drainage catheter under echo guidance using local anaesthesia is the method of choice in the management of pericardial effusions and cardiac tamponade and prevents the need for diagnostic needle pericardiocentesis which has a high false positive and false negative rate. An unusually large amount of blood was aspirated (500 ml) with no diminution of flow, suggesting the possibility of right atrial or ventricular rupture. TOE probe placement is routine before all cardiac surgical procedures in our institution. This confirmed that the pigtail catheter was in the pericardial cavity and allowed the effusion to be drained under direct vision and to see if the effusion would reaccumulate. It also allowed the right ventricle, valves and interatrial septum to be seen more accurately than with the TTE. Because the effusion did not reaccumulate 30 min after drainage, we felt that cardiac rupture was not present and the patient could be managed conservatively without exploratory surgery. Without TOE, the patient would have undergone unnecessary surgery.

In summary pericardial tamponade is an uncommon but life threatening condition. It can mimic other conditions such as hypovolaemia particularly after trauma. A high index of suspicion must be retained if it is to be diagnosed and treated effectively.

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Ipsilateral thoraco-lumbar anaesthesia and paravertebral spread after low thoracic paravertebral injection

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We report ipsilateral thoraco-lumbar anaesthesia and paravertebral spread of contrast after injection through a thoracic paravertebral catheter that was placed at the right T8–9 spinal level for pain management in a patient with multiple fractured ribs. We review the literature and describe the subendothoracic fascial communication between the thoracic paravertebral...
Thoracic paravertebral injection of local anaesthetic produces ipsilateral somatic and sympathetic nerve blockade in multiple contiguous thoracic dermatomes above and below the site of injection. The origin of the psoas major muscle is described to completely seal off the thoracic paravertebral space below the level of the 12th thoracic vertebra and caudal spread of a thoracic paravertebral injection below this level through the paravertebral space is thought to be unlikely. Clinical ipsilateral thoraco-lumbar anaesthesia has occasionally been described, challenging the concept of lumbar nerve sparing following thoracic paravertebral block. To resolve this controversy, Saito et al. recently performed a cadaveric study and demonstrated ipsilateral spread of coloured dye from the thoracic paravertebral space to the retroperitoneal lumbar paravertebral region. Dye was seen to spread in the endothoracic fascia of the thorax and extend into the abdomen through the medial and lateral arcuate ligaments to involve the fascia transversalis and the lumbar spinal nerves. However, the fascial communications between the thoracic paravertebral space and the retroperitoneal lumbar paravertebral region were not discussed in this report and the authors state that ‘the actual fluid communications between the endo- thoracic and transversalis fascias is not well-known’. Thus the fascial communication between the thoracic paravertebral space and the retroperitoneal space still remains unexplained. In this report we describe ipsilateral thoraco-lumbar anaesthesia and paravertebral spread of contrast in vivo and review the fascial communications between the lower thoracic paravertebral space and the retroperitoneal space to account for this spread.

Case report
A 63-year-old previously healthy man, weighing 60 kg was referred to our pain team for management of right-sided fractured ribs, which had compromised his ability to breathe deeply and cough effectively. Pain was rated as severe by the patient with a visual analogue score (VAS: 0 – no pain and 100 – worst imaginable pain) of 80 at rest and 100 on coughing. Oxygen saturation was 96% with $P_{aO_2}$ 7.8 kPa and $P_{aCO_2}$ 4.4 kPa breathing room air. A chest radiograph demonstrated fractured right 8–10th ribs with no pneumothorax or haemothorax. After informed consent, a right-sided thoracic paravertebral block was performed at the level of T7–8 with the patient in the sitting position using a 16-gauge Tuohy needle (Minipack, Portex, UK) according to the technique described by Eason and Wyatt, and 3 cm of the catheter was inserted into the paravertebral space. With the catheter safely secured to the back, the patient was returned to the supine position. After negative aspiration of the catheter for blood and CSF, 18 ml of 0.5% bupivacaine with 1:200 000 epinephrine was administered in small aliquots over a 3-min period. The patient soon became pain free. Thirty minutes following the paravertebral injection, the VAS for pain was 0 at rest and 20 on coughing, and ipsilateral anaesthesia to temperature (cold) was elicited from the T7–T10 dermatomes with no contralateral extension. A continuous infusion of bupivacaine 0.25% was commenced at 7 ml h$^{-1}$ and regular oral diclofenac 75 mg twice daily was also prescribed. The patient remained

Fig 1 Chest x-ray (anteroposterior view) after injection of contrast through the paravertebral catheter. Note ipsilateral thoraco-lumbar paravertebral spread from T10 to L2.
comfortable, was able to breathe deeply, complied with chest physiotherapy and was soon mobilized. On the second day after the thoracic paravertebral catheter placement, it was noted that the patient was having increasing pain (VAS: 30 at rest and 70 on coughing). On clinical examination there was no demonstrable cutaneous anaesthesia over the chest or abdomen and on inspection of the catheter insertion site it was apparent that the catheter had dislodged out of the thoracic paravertebral space.

After discussion with the patient, he requested to have the thoracic paravertebral catheter resited. Using the same technique the right thoracic paravertebral space was accessed one interspace lower at the T8–9 level and 3 cm of catheter was inserted into the thoracic paravertebral space. The catheter was tunneled subcutaneously and safely secured to the back. A total of 10 ml of 0.5% bupivacaine with 1:200 000 epinephrine was injected via the catheter over a 2-min period with the patient in the supine position. The patient once again became pain free. Thirty minutes following the injection, the VAS was 0 at rest and 20 on coughing and ipsilateral cutaneous anaesthesia to temperature (cold) was elicited from T7–L3 dermatomes. There were no significant haemodynamic changes or evidence of motor blockade in the distribution of the lumbar spinal nerves bilaterally as judged by normal hip flexion, knee extension and hip adduction.

To confirm the position of the catheter and demonstrate the spread of the paravertebral injection 10 ml of Iopamiro-300 (Iopamidol-300 mg ml⁻¹, Bracco s.p.a., Milano, Italia)

![Diagram](image)

**Fig 2** Saggital section showing the fascial relations of the lower thoracic paravertebral space and the retroperitoneal space.

![Diagram](image)

**Fig 3** Anatomical relations of the fascia covering the psoas major, quadratus lumborum and fascia transversalis to the retroperitoneal space.
was injected via the indwelling paravertebral catheter distal to the bacterial filter. Immediately following this injection an anteroposterior chest x-ray was taken (Fig. 1). Ipsilateral paravertebral spread of contrast from the ninth thoracic to the second lumbar segment below the diaphragm was noted on the chest x-ray (Fig. 1).

**Discussion**

Thoracic paravertebral injection of local anesthetic produces ipsilateral somatic and sympathetic nerve blockade in multiple thoracic dermatomes above and below the site of injection. This results from spread to the contiguous thoracic paravertebral space, the intercostal space laterally and the epidural space medially. The thoracic paravertebral injection in our patient also produced multidermalomatous ipsilateral thoracic anaesthesia, which was effective in relieving pain caused by the multiple fractured ribs. However after the second paravertebral injection we observed ipsilateral thoraco-lumbar anaesthesia extending from T7 to L3 dermatomes with no motor involvement of the lumbar spinal nerves. The post-contrast chest x-ray also demonstrates ipsilateral thoraco-lumbar (T9–L2) paravertebral spread of contrast (Fig. 1).

There is controversy whether low thoracic paravertebral block can extend into the lumbar region. Lönnqvist and Hildingsson examined the caudal limit of the thoracic paravertebral space in eviscerated cadavers by approaching the thoracic paravertebral space internally from the thoracic cavity. Based on observations made after probing and dye injection, they concluded that the origin of the psoas major muscle completely sealed off the thoracic paravertebral space below the level of the 12th thoracic vertebra, and proposed that spread of a thoracic paravertebral block below this level through the paravertebral space was unlikely. However ipsilateral thoraco-lumbar anaesthesia, radiological spread of contrast below the diaphragm and thoraco-lumbar spread of coloured dye in cadavers has been described, challenging the concept of lumbar nerve sparing following thoracic paravertebral block.

The incidence of ipsilateral thoraco-lumbar anaesthesia after thoracic paravertebral block is not known but published data suggest that it is more common after low thoracic paravertebral injections. Richardson et al. report ipsilateral L1 spinal nerve involvement in three of the ten patient studied after paravertebral injection of 1.5 mg kg bupivacaine 0.5% at T6 and T10 level respectively. Cheema et al. performed paravertebral injections at a mean level of T9–10 (range T7–8 to T10–11) and report mean ipsilateral anaesthesia of five dermatomes (range 1–8), with upper and lower limits of T6 and L3, after 15 ml of bupivacaine 0.5%. Saito et al. report ‘broad unilateral anaesthesia’ extending from the left T4 to L3 after injection of local anesthetic through an epidural catheter, which was inadvertently inserted in the left T11 paravertebral space. More recently, Saito et al., in a cadaveric study, demonstrated ipsilateral retroperitoneal lumbar paravertebral spread of crimson dye along the endoathoracic fascia and fascia transversalis through the medial and lateral arcuate ligament, after thoracic paravertebral injection at T11. The dye stained the ipsilateral subcostal, iliohypogastric, ilioinguinal, genitofemoral and lateral femoral cutaneous nerve in all 12 cadavers studied, and in two cases the dye also reached the femoral nerve. On average, spread extended from the 6th intercostal nerve to the lateral femoral cutaneous nerve (T6–L2). All of these reports of ipsilateral thoraco-lumbar anaesthesia and paravertebral spread in vivo and in cadavers suggests that there is a fascial plane of communication between the ipsilateral thoracic paravertebral space and the retroperitoneal space. Review of the literature shows that such an anatomical plane of communication exists which may account for ipsilateral thoraco-lumbar anaesthesia.

The endoathoracic fascia, also referred to as the ‘internal thoracic fascia’, is a fibroelastic structure that forms the deep fascia of the thorax and lines the internal surface of the intercostal muscle, the intervening ribs, and the diaphragm. At the diaphragm, the endoathoracic fascia is very thin, being thinnest at the upper surface and thickest at its edges. Inferiorly the endoathoracic fascia is continuous with the fascia transversalis with the fascia transversalis blends medially with the anterior layer of the quadratus lumborum fascia and the psoas fascia (psoas sheath) (Fig. 3). The fascia transversalis blend is continuous with the fascia transversalis and iliohypogastric (L1) and ilioinguinal (L1) nerves course anterior to and in contact with the quadratus lumborum, while the genitofemoral nerve (L1, L2) descends on the ventral surface of the psoas major muscle and the lateral femoral cutaneous nerve (L2, L3) crosses the lateral border of the psoas muscle at the level of the inferior margin of L4 vertebra in this fascial plane. The fascia overlying the upper end of the psoas major muscle (psoas fascia) is thickened to form the medial arcuate ligament, which is attached medially to the body of L2 and laterally to the transverse process of L1. The psoas major muscle courses under this fascial arch, also referred to as the ‘open end of the psoas sheath’, to enter the posterior mediastinum and lie in contact with the lower thoracic vertebra and pleura. It is through this fascial arch that tuberculous suppurate of the lower thoracic spine is thought to enter the psoas sheath and present as an abscess in the retroperitoneum or groin. This may also be the route by which the genito-femoral nerve, which lies on the ventral surface of the psoas major muscle, is involved. Lönnqvist and Hildingsson, in their cadaver study, also observed passage of a guide wire or dye below the level of T12 in the fascial plane above the psoas muscle on two occasions, which the authors attributed to over-vigorous probing or injection, but may also be explained by the above mechanism.
Based on the fascial anatomy described, an injection in the lower thoracic paravertebral space posterior to the endothoracic fascia can spread caudally via the medial and lateral arcuate ligament to the retroperitoneal space in the abdomen. Since this results in spread anterior to the surface of the quadratus lumborum and psoas major muscle, the subcostal, iliohypogastric, ilioinguinal, genitofemoral and the lateral femoral cutaneous nerve may be involved. This is the anatomical basis of the technique of ‘extended unilateral anaesthesia’ and may also be the mechanism involved in our patient.

In summary, this case report demonstrates that ipsilateral thoraco-lumbar anaesthesia and paravertebral spread can occur after low thoracic paravertebral injection. Based on current evidence and anatomical knowledge the mechanism for this observation is an extended subendothoracic fascial spread from the thoracic paravertebral space to the retroperitoneal space in relation to the anterior surface of the psoas major and quadratus lumborum muscle where it affects the lumbar spinal nerves. This may have clinical application in the management of acute and chronic pain of unilateral thoraco-lumbar origin.

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