Thoracic paravertebral block: radiological evidence of contralateral spread anterior to the vertebral bodies

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We report contralateral spread of contrast medium anterior to the vertebral bodies after injection of contrast through a thoracic paravertebral catheter that was used to manage pain in a patient with multiple fractured ribs. We review the literature and propose that the anatomical basis for this observation is spread in the extrapleural compartment of the thoracic paravertebral space along the subserous fascial plane.


Keywords: anaesthetic techniques, regional, paravertebral; anatomy, paravertebral space

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Thoracic paravertebral block is the technique of injection of local anaesthetic alongside the thoracic vertebra, which results in ipsilateral somatic and sympathetic nerve block, spreading to levels above and below the site of injection.1 Contralateral anaesthesia2–4 adjacent to the site of injection occurs in 1.1% of paravertebral injections.5 Although the exact mechanism involved in segmental contralateral anaesthesia is still not defined, epidural spread6 or contralateral spread anterior to the vertebrae7 has been suggested.8 However, the mode of contralateral spread anterior to the vertebra still remains controversial and in a recent review on thoracic paravertebral block, the authors stated that ‘gross anterior spread is not possible unless the parietal pleura has been traumatized’.9 In this report we provide radiological evidence of contralateral spread anterior to the vertebral bodies after successful thoracic paravertebral block for multiple fractured ribs and propose an anatomical basis for this mode of spread.

Case report

An 89-yr-old man, weighing 65 kg, sustained multiple fractures of his left ribs with a flail segment after a fall. His main complaints were severe left-sided chest pain, which had markedly reduced his ability to breathe deeply, cough and expectorate. Oxygen saturation was 92% with \(P_{\text{aO}_2}\) 8.4 kPa and \(P_{\text{aCO}_2}\) 4.4 kPa breathing room air. A chest x-ray showed fractured third to seventh ribs on the left with an associated small pleural effusion and surgical emphysema. The aortic arch was unfolded and no mediastinal shift was noted. He was referred to our pain team for pain management to facilitate respiratory care and chest physiotherapy. After informed consent, a left-sided thoracic paravertebral block was performed at the level of the fifth thoracic spine using a 16-gauge Tuohy needle (Minipack, Portex, UK), according to the technique described by Eason and Wyatt,10 and 3 cm of an epidural catheter were inserted into the paravertebral space. After negative aspiration of the catheter for blood and CSF, a total of 20 ml of 0.5% bupivacaine with epinephrine 1:200 000 was administered over a 2-min period. The patient remained in the supine position for a further 15 min after which he reported marked pain relief. Ipsilateral anaesthesia was elicited from the second to the ninth thoracic segments, as judged by pinprick and temperature (cold), and gently springing the fractured ribs elicited no pain. No contralateral anaesthesia could be elicited and there were no significant haemodynamic changes.

To confirm the position of the catheter and demonstrate the distribution of the paravertebral injection, Iopamiro-300 10 ml (Iopamidol) diluted to 20 ml with normal saline was injected via the paravertebral catheter distal to the bacterial filter followed immediately by anteroposterior and lateral chest x-rays (Figs 1, 2). Ipsilateral spread of contrast over eight thoracic segments with contralateral spread of contrast adjacent to the sixth thoracic vertebra was also seen on the frontal chest x-ray (Fig. 1). In addition, the lateral chest x-ray also demonstrated spread of contrast onto the lateral and anterior surface of the vertebral bodies (Fig. 2) adjacent to the level of catheter placement.

Discussion

A thoracic paravertebral injection can spread to the contiguous spaces above and below, the epidural space mediailly...
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The presence of a distinct radiological pattern of contrast spread unlike interpleural injection of contrast that defines no anatomical plane indicated that the injection was extrapleural in our patient. Further evidence to support extrapleural paravertebral location was the spread of contrast posterior to the vertebral bodies on the lateral chest radiograph (Fig. 2).

Conacher, using the traditional method of thoracic paravertebral injection in cadavers, observed that injected resin spread to the lateral surfaces of the vertebrae but in none of their dissections did the resin cross the midline. However, spread across the midline of radio-opaque contrast medium in vivo and coloured dye in cadavers has subsequently been reported. In one of the two cases reported by Lönqvist and Hesser where contrast medium was seen to cross the midline on a frontal chest x-ray, the authors also observed two dermatomes of contralateral anaesthesia without radiological evidence of epidural extension. Tenicela and Pollan described paravertebral–peridural block, a modification of the traditional method of thoracic paravertebral injection, which they used to investigate the possible mechanism of contralateral anaesthesia in four fresh cadavers by injecting coloured Latex. Tenicela and Pollan observed spread of Latex anteriorly from the paravertebral space to the prevertebral area in all their dissections, with frequent extension to the most anterior parts of the contralateral paravertebral space. Contralateral spread of dye anterior to the vertebral bodies without evidence of interpleural spread has also been reported by Mowbray, Wong and Murray after a more peripheral intercostal injection. All of these reports of contralateral spread anterior to the vertebral bodies in both cadavers and in vivo suggest that there is an extrapleural anatomical plane of communication between the intercostal spaces on either side of the thorax anterior to the vertebral bodies through the paravertebral spaces. Review of the literature shows that such an anatomical plane of communication exists.

The thoracic paravertebral space is described as a wedge-shaped space sandwiched between the head and necks of the ribs, which has been used successfully to manage pain in patients with multiple fractured ribs. The paravertebral injection in our patient also produced multiple unilateral intercostal nerve block which was effective in relieving pain caused by multiple fractured ribs. However, the post-contrast chest x-rays, apart from demonstrating ipsilateral paravertebral and intercostal spread, also demonstrated spread of contrast onto the lateral and anterior surface of the vertebral bodies.

and the intercostal space laterally. This results in multiple unilateral somatic and sympathetic nerve block which has been used successfully to manage pain in patients with multiple fractured ribs. The paravertebral injection in our patient also produced multiple unilateral intercostal nerve block which was effective in relieving pain caused by multiple fractured ribs. However, the post-contrast chest x-rays, apart from demonstrating ipsilateral paravertebral and intercostal spread, also demonstrated spread of contrast onto the lateral and anterior surface of the vertebral bodies with contralateral extension (Figs 1, 2).
is an intervening layer of areolar connective tissue,\textsuperscript{17–19} the 'subserous fascia',\textsuperscript{17,19} which provides the connective tissue investment for the mediastinal structures.\textsuperscript{17} This acts as a channel of communication for the paravertebral spaces on either side anterior to the vertebral bodies (Fig. 3). The vertebral attachment of the endothoracic fascia prevents anterior vertebral spread of contrast\textsuperscript{19} and may prevent epidural spread after an extrapleural paravertebral injection. Based on the anatomy described, an extrapleural paravertebral compartment injection could spread to the contiguous spaces above and below, the intercostal spaces laterally and via the subserous layer of connective tissue to the anterior surface of the vertebra and on to the contralateral paravertebral space.

In summary, we have demonstrated that a thoracic paravertebral injection, apart from producing multi-dermatomal unilateral anaesthesia, can also result in contralateral paravertebral spread anterior to the vertebral bodies. We believe that the anatomical basis for this observation is spread in the extrapleural paravertebral compartment along the subserous layer of connective tissue.

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