Continuous Thoracic Paravertebral Infusion of Bupivacaine for Pain Management in Patients With Multiple Fractured Ribs*

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Study objective: To evaluate the efficacy of a continuous thoracic paravertebral infusion of bupivacaine for pain management in patients with unilateral multiple fractured ribs (MFR).

Design: Prospective nonrandomized case series.

Setting: Multidisciplinary tertiary hospital.

Patients: Fifteen patients with unilateral MFR.

Interventions: Insertion of a catheter into the thoracic paravertebral space. We administered an initial injection of 0.3 mL/kg (1.5 mg/kg) bupivacaine 0.5% with 1:200,000 epinephrine followed 30 min later by an infusion of bupivacaine 0.25% at 0.1 to 0.2 mL/kg/h for 4 days.

Measurements and results: The following parameters were measured during the initial assessment before thoracic paravertebral block (TPVB), 30 min after the initial injection, and during follow-up on day 1 and day 4 after commencing the infusion of bupivacaine: visual analog pain score at rest and during coughing; respiratory rate; arterial oxygen saturation (SaO₂); bedside spirometry (i.e., FVC, FEV₁, FEV₁/FVC ratio, and peak expiratory flow rate [PEFR]); arterial blood gas measurements; and O₂ index (i.e., PaO₂/fraction of inspired oxygen ratio). There were significant improvements in pain scores (at rest, p < 0.002; during coughing, p = 0.001), respiratory rate (p < 0.0001), FVC (p = 0.007), PEFR (p = 0.01), SaO₂ (p = 0.04), and O₂ index (p = 0.01) 30 min after the initial injection, which were sustained for the 4 days that the thoracic paravertebral infusion was in use (p < 0.05). PaCO₂ did not change significantly after the initial injection, but on day 4 it was significantly lower than the post-TPVB value (p = 0.04). One patient had an inadvertent epidural injection, and another developed transient ipsilateral Horner syndrome with sensory changes in the arm. No patient exhibited clinical signs of inadvertent intravascular injection or local anesthetic toxicity.

Conclusion: Our results confirmed that continuous thoracic paravertebral infusion of bupivacaine is a simple and effective method of providing continuous pain relief in patients with unilateral MFR. It also produced a sustained improvement in respiratory parameters and oxygenation.

Key words: analgesia; anesthetic technique; blunt chest trauma; bupivacaine; pain control; paravertebral anesthetic; paravertebral catheter; regional anesthetic; rib fracture; trauma

Abbreviations: FIO₂ = fraction of inspired oxygen; MFR = multiple fractured ribs; SaO₂ = arterial oxygen saturation; TPVB = thoracic paravertebral block; VAS = visual analog scale

Multiple fractured ribs (MFR) cause severe pain that adversely affects a patient’s ability to cough and breathe deeply, predisposing the patient to sputum retention and respiratory insufficiency. Effective analgesia, chest physiotherapy, and respiratory care are the cornerstones of management. Effective analgesia is vital because it allows patients to breathe deeply, cough effectively, and comply with chest physiotherapy.

Thoracic paravertebral block (TPVB), which produces multidermatomal, ipsilateral, somatic, and sympathetic nerve blockade, is one of the thera-

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therapeutic options for managing pain in patients with MFR. A single, large-volume (ie, 20 to 30 mL), percutaneous, thoracic paravertebral injection of bupivacaine 0.5% provides effective analgesia and improves respiratory parameters and arterial blood gas tension in patients with unilateral MFR. This approach, although effective, is limited by the resurgence of pain and deterioration in respiratory parameters, necessitating repeated paravertebral injections. This may not be considered an optimal analgesic regimen and may be overcome by a continuous TPVB. Several case reports have described the use of continuous TPVB, as regular bolus injections or as a continuous infusion of local anesthetic via an indwelling paravertebral catheter for pain control in patients with MFR. However, the effects of continuous TPVB on respiratory function and oxygenation in patients with MFR have not been described. We now report our experience using a continuous thoracic paravertebral infusion of bupivacaine for pain management in patients with unilateral MFR.

**Materials and Methods**

Fifteen consecutive adult trauma patients who had been referred to the Acute Pain Service of the Prince of Wales Hospital for the management of pain caused by unilateral MFR were prospectively enrolled in the study after written informed consent for a continuous TPVB was obtained. The patients who were enrolled had three or more unilateral fractured ribs. In all cases, cardiovascular stability had been established, any pneumothorax or hemothorax had been drained, thoracic and abdominal visceral injuries had been excluded, and any surgical procedure that was required had been performed. Patients were excluded from the study if they had a known allergy to local anesthetic drugs, known liver or renal disease, infection at the site of needle insertion, or were receiving warfarin. As patients were required to report pain scores by using a visual analog scale (VAS) and to perform bedside spirometry before and after the institution of the use of continuous TPVB, as regular bolus injections or as a continuous infusion of local anesthetic via an indwelling paravertebral catheter, for pain control in patients with MFR. However, the effects of continuous TPVB on respiratory function and oxygenation in patients with MFR have not been described. We now report our experience using a continuous thoracic paravertebral infusion of bupivacaine for pain management in patients with unilateral MFR.

**Results**

Continuous thoracic paravertebral infusion of bupivacaine was used to manage pain in 15 adult patients with unilateral MFR, in whom the dominant injury requiring treatment was blunt chest trauma. Patient characteristics with details of their injuries and opioids used before the institution of TPVB are summarized in Table 1. There were 11 men and 4 women with a mean age of 52.8 years (19.8 years) [range, 23 to 89 years], a mean weight of 63.4 kg and was advanced 2 to 3 cm into the paravertebral space. The catheter was tunneled subcutaneously and was secured to the back with adhesive dressings, and the patient was returned to the supine position. We graded the ease with which the catheter was inserted as easy, some resistance encountered, difficult, and impossible. After negative aspiration through the catheter, 0.3 mL/kg (1.5 mg/kg) bupivacaine 0.5% with 1:200,000 solution of epinephrine was injected slowly for > 3 min in small aliquots with the patient in the supine position. BP and heart rate were recorded every 5 min for the next 30 min. Any procedure-related complication was noted, and the dermalatal distribution of loss of sensation to cold (ice) was determined after 30 min. A continuous infusion of bupivacaine 0.25% then was commenced at 0.1 mL/kg/h. Regular oral diclofenac (75 mg every 12 h) or dextropropoxyphene chloride, 32.5 mg, with paracetamol, 320 mg (Dolpocetmol; Synco Ltd; Hong Kong), was coadministered (2 tablets every 6 h) in patients with contraindications to the use of nonsteroidal analgesic agents. Patients were managed in the thoracic surgical ward, and no additional monitoring or nursing care was ordered. One of the investigators or a member of our pain team reviewed the patients twice daily for 4 days. During follow-up, the paravertebral infusion rate was increased (1 to 2 mL/h each time to a maximum infusion rate of 0.2 mL/kg/h) if the visual analog scale (VAS) pain score (0, no pain; 100, worst imaginable pain) on coughing was > 40 if the patient requested additional analgesia. The rate adjustment was performed by the administration of a bolus of 3 to 4 mL bupivacaine 0.25%. All patients were encouraged to perform breathing exercises using an incentive deep-breathing exerciser (Triflo II; Sherwood Medical; St. Louis, MO) and received regular chest physiotherapy.

The following parameters were measured pre-TPVB, at 30 min post-TPVB, on post-TPVB day 1, and on post-TPVB day 4: VAS pain score at rest and on coughing; respiratory rate; arterial oxygen saturation (SatO2); bedside spirometry (ie, FVC, FEV1, FEV1/FVC ratio, and peak expiratory flow rate) using a ventilometer (VM1; Clement Clarke; Harlow, UK); fraction of inspired oxygen (FiO2) in patients who were receiving O2; and arterial blood gas tension. The inspired oxygen concentration was kept constant before and after TPVB, and subsequently, on days 1 and 4, the FiO2 delivered via a Venturi mask was recorded. The O2 index (ie, PaO2/FiO2 ratio) was calculated from the above data. Patient cooperation with bedside spirometry often was limited by pain and discomfort.

The data were analyzed using a statistical software package (SPSS for Windows, version 10; SPSS Inc; Chicago, IL). A Kolmogorov-Smirnov test was used to test the normality of the data recorded. The data are presented as the mean (SD) when normally distributed or as the median (range) when not normally distributed. Appropriate parametric (paired t test) and nonparametric tests (Wilcoxon signed ranks test) were used. A p value of < 0.05 was considered to be statistically significant.
dermatomes (range, 1 to 3 dermatomes) above and the distribution of the loss of cold sensation was 1.5 dermatomes (range, 3 to 11 dermatomes). The median ipsilateral loss of sensation to cold of the initial injection of bupivacaine produced a median higher level.

In four patients, blood-stained fluid was aspirated through the catheter, and in one case frank blood flowed from the Tuohy needle (case 4). In the former case, it was possible to flush the catheter clear of blood with saline solution, but in the latter case the paravertebral injection was repeated at a higher level.

TPVBs were successful in all patients, and the initial injection of bupivacaine produced a median ipsilateral loss of sensation to cold of >5 dermatomes (range, 3 to 11 dermatomes). The median distribution of the loss of cold sensation was 1.5 dermatomes (range, 1 to 3 dermatomes) above and 2.5 dermatomes (range, 0 to 9 dermatomes) below the level of injection (Fig 1). In a number of patients (cases 3, 5 and 12), few segments of contralateral sensory loss (3 to 6 dermatomes) were present. In one patient (case 9), bilateral symmetrical anesthesia (ipsilateral, T3 to T11; contralateral, T3 to T8) was present. The patient also developed hypotension that required treatment with IV fluid (1 L normal saline solution) and a vasopressor (metaraminol, 2 mg [total]). Subsequently, inadvertent epidural injection was confirmed radiologically (Fig 2), and the patient was treated as having an epidural block with a continuous infusion of bupivacaine 0.125% and fentanyl, 2.5 µg/mL at 0.1 to 0.2 mL/kg/h. This case was excluded from our final statistical analysis of TPVB characteristics. In the remaining 14 patients who were managed using the continuous thoracic paravertebral infusion, the infusion rate had to be increased in 10 patients (71.4%) such that the mean infusion rates on days 1, 2, and 4 were 7 mL (1.17 mL) [range, 6 to 10 mL], 8 mL (1.92 mL) [range, 6 to 12 mL], and 8 mL (1.70 mL) [range, 6 to 12 mL], respectively.

There was significant improvement in pain scores measured both at rest (p = 0.002) and during coughing (p = 0.001) after the initial treatment, and the improvements in pain scores were sustained for the 4 days (p < 0.01) that the thoracic paravertebral

<table>
<thead>
<tr>
<th>Case No./Age, yr/Gender/Weight, kg</th>
<th>Mode of Injury</th>
<th>Fractured Ribs (Total No.)</th>
<th>Side of Fractured Ribs</th>
<th>Flail Segment</th>
<th>Coexisting Injury</th>
<th>Pulmonary Contusion</th>
<th>Pre-TPVB Mode of Analgesia</th>
<th>Time From Hospital Admission to TPVB, h</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/73/F/50</td>
<td>Fall</td>
<td>3–8 (6)</td>
<td>Left</td>
<td>No</td>
<td>None</td>
<td>None</td>
<td>IM meperidine</td>
<td>19</td>
</tr>
<tr>
<td>2/72/F/87</td>
<td>MVA</td>
<td>2–7 (7)</td>
<td>Left</td>
<td>No</td>
<td>None</td>
<td>None</td>
<td>IVPCA morphine</td>
<td>18</td>
</tr>
<tr>
<td>3/34/M/65</td>
<td>MVA</td>
<td>5–8 (4)</td>
<td>Right</td>
<td>No</td>
<td>None</td>
<td>Ipsilateral</td>
<td>IVPCA morphine</td>
<td>11</td>
</tr>
<tr>
<td>4/46/F/60</td>
<td>Assault</td>
<td>5–9 (5)</td>
<td>Left</td>
<td>No</td>
<td>None</td>
<td>None</td>
<td>IM meperidine</td>
<td>28</td>
</tr>
<tr>
<td>5/41/M/50</td>
<td>MVA</td>
<td>5–7 (3)</td>
<td>Right</td>
<td>No</td>
<td>Fractured right forearm; chest drain for hemothorax</td>
<td>Bilateral</td>
<td>IM dextropropoxiphene</td>
<td>60</td>
</tr>
<tr>
<td>6/54/M/70</td>
<td>Assault</td>
<td>2–6 (5)</td>
<td>Right</td>
<td>No</td>
<td>None</td>
<td>None</td>
<td>IM dextropropoxiphene</td>
<td>20</td>
</tr>
<tr>
<td>7/53/M/60</td>
<td>Crush injury</td>
<td>3–5 (3)</td>
<td>Left</td>
<td>No</td>
<td>Fractured left clavicle; Pott fracture, right ankle</td>
<td>Bilateral</td>
<td>IVPCA morphine</td>
<td>3</td>
</tr>
<tr>
<td>8/76/F/45</td>
<td>Fall</td>
<td>4–8 (5)</td>
<td>Left</td>
<td>No</td>
<td>None</td>
<td>None</td>
<td>IM dextropropoxiphene</td>
<td>22</td>
</tr>
<tr>
<td>9/52/M/52</td>
<td>Fall</td>
<td>5–9 (5)</td>
<td>Left</td>
<td>No</td>
<td>Fractured left clavicle</td>
<td>None</td>
<td>IM dextropropoxiphene</td>
<td>14</td>
</tr>
<tr>
<td>10/89/M/60</td>
<td>Fall</td>
<td>3–8 (6)</td>
<td>Left</td>
<td>Yes</td>
<td>None</td>
<td>None</td>
<td>IVPCA morphine</td>
<td>3.5</td>
</tr>
<tr>
<td>11/53/M/80</td>
<td>MVA</td>
<td>2–8 (7)</td>
<td>Right</td>
<td>No</td>
<td>Fractured right scapula, fractured right ulnar head</td>
<td>Bilateral</td>
<td>IVPCA morphine</td>
<td>16</td>
</tr>
<tr>
<td>12/33/M/60</td>
<td>MVA</td>
<td>2–6 (5)</td>
<td>Left</td>
<td>No</td>
<td>Nil, chest drain for pneumothorax</td>
<td>None</td>
<td>IM meperidine</td>
<td>13.5</td>
</tr>
<tr>
<td>13/63/M/60</td>
<td>Fall</td>
<td>8–10 (3)</td>
<td>Right</td>
<td>No</td>
<td>None</td>
<td>None</td>
<td>IM meperidine</td>
<td>44</td>
</tr>
<tr>
<td>14/29/M/60</td>
<td>MVA</td>
<td>6–9 (4)</td>
<td>Left</td>
<td>No</td>
<td>Retroperitoneal duodenal (D3) tear (postlaparotomy day 3), chest drain for pneumothorax</td>
<td>None</td>
<td>IVPCA morphine</td>
<td>78</td>
</tr>
<tr>
<td>15/23/M/74</td>
<td>MVA</td>
<td>6 (3–8)</td>
<td>Left</td>
<td>No</td>
<td>Fractured left humerus</td>
<td>None</td>
<td>IVPCA morphine</td>
<td>98</td>
</tr>
</tbody>
</table>

*F = female; M = male; MVA = motor vehicle accident; IVPCA = IV patient-controlled analgesia.

(11.3 kg) [range, 45 to 87 kg], and a mean number of involved ribs of 5 (1.36) [range, 3 to 7].

TPVBs were commenced a median of 19.5 h (range, 3 to 98 h) after admission to the hospital. Paravertebral catheters were inserted between the third and the eighth thoracic spinal levels. The mean depth from the skin to the thoracic paravertebral space was 5.07 cm (0.73 cm) [range, 4 to 6.5 cm]. It was possible to pass the catheter in all patients, although the ease of insertion varied from easy (three cases), some resistance encountered (seven cases), to difficult (five cases). In one patient, several attempts at needle insertion were required before the catheter was successfully inserted (case 8). Five patients reported paresthesia during needle or catheter insertion. In four patients, blood-stained fluid was aspirated through the catheter, and in one case frank blood flowed from the Tuohy needle (case 4). In the former case, it was possible to flush the catheter clear of blood with saline solution, but in the latter case the paravertebral injection was repeated at a higher level.

TPVBs were successful in all patients, and the initial injection of bupivacaine produced a median ipsilateral loss of sensation to cold of >5 dermatomes (range, 3 to 11 dermatomes). The mean distribution of the loss of cold sensation was 1.5 dermatomes (range, 1 to 3 dermatomes) above and 2.5 dermatomes (range, 0 to 9 dermatomes) below the level of injection (Fig 1). In a number of patients (cases 3, 5 and 12), few segments of contralateral sensory loss (3 to 6 dermatomes) were present. In one patient (case 9), bilateral symmetrical anesthesia (ipsilateral, T3 to T11; contralateral, T3 to T8) was present. The patient also developed hypotension that required treatment with IV fluid (1 L normal saline solution) and a vasopressor (metaraminol, 2 mg [total]). Subsequently, inadvertent epidural injection was confirmed radiologically (Fig 2), and the patient was treated as having an epidural block with a continuous infusion of bupivacaine 0.125% and fentanyl, 2.5 µg/mL at 0.1 to 0.2 mL/kg/h. This case was excluded from our final statistical analysis of TPVB characteristics. In the remaining 14 patients who were managed using the continuous thoracic paravertebral infusion, the infusion rate had to be increased in 10 patients (71.4%) such that the mean infusion rates on days 1, 2, and 4 were 7 mL (1.17 mL) [range, 6 to 10 mL], 8 mL (1.92 mL) [range, 6 to 12 mL], and 8 mL (1.70 mL) [range, 6 to 12 mL], respectively.

There was significant improvement in pain scores measured both at rest (p = 0.002) and during coughing (p = 0.001) after the initial treatment, and the improvements in pain scores were sustained for the 4 days (p < 0.01) that the thoracic paravertebral

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infusion was in use. No patient required any additional administration of systemic opioids as rescue analgesia once the TPVB had been established. There was also improvement in respiratory function with decreases in respiratory rate ($p < 0.0001$), and there were increases in FVC ($p = 0.007$), peak expiratory flow rate ($p = 0.01$), SaO$_2$ ($p = 0.04$), and O$_2$ index ($p = 0.01$) after the initial treatment. These improvements also were sustained ($p < 0.05$) for the 4 days that the thoracic paravertebral infusion was in use. The FEV$_1$/FVC ratio was not affected by the TPVB. The mean PaCO$_2$, which was 5.29 kPa (1.03 kPa) [range, 3.95 to 6.52 kPa] pre-TPVB, did not change significantly after the initial injection (5.42 kPa [0.86 kPa]; range, 4.3 to 6.5 kPa), but on day 4 it was significantly lower (4.98 kPa [0.45 kPa]; range, 4.3 to 5.9 kPa) than the post-TPVB value ($p = 0.04$). Changes in pain scores, respiratory parameters, PaCO$_2$, SaO$_2$, and O$_2$ index are shown in Figures 3 and 4. BP and heart rate were unaffected by the initial paravertebral injection (Fig 5). No patient exhibited clinical signs of inadvertent intravascular injection or local anesthetic toxicity. In one patient (case 12), ipsilateral Horner syndrome and sensory changes in the ipsilateral arm were noted 2 days after the commencement of the thoracic paravertebral infusion, which resolved after the discontinuation of the bupivacaine infusion.

**DISCUSSION**

Our case series shows that patients with unilateral MFR managed by a continuous TPVB achieve continuous and effective pain relief with improvement in respiratory function and oxygenation. However, our findings need be interpreted with caution, as they are observational and are not from a randomized controlled study. In addition to our own experience, previous reports have shown the efficacy of using TPVB as a single injection in patients with MFR and as a continuous infusion in postthoracotomy patients. Hence, as our patients were referred after being inadequately treated by opiates alone, we could not justify the inclusion of a control group. Furthermore, we did not evaluate primary outcomes such as the incidence of pulmonary complications and pneumonia, so we do not know whether the observed improvement in respiratory function and oxygenation can be translated to a better patient outcome.

Like Eason and Wyatt, we also found TPVB placement technically simple and easier to perform than thoracic epidural placement. Patients with MFR are often uncooperative during catheter placement due to pain, which makes the less risky paravertebral technique more desirable.

Unlike epidural catheter insertion, we frequently encountered resistance during paravertebral catheter insertion. Other researchers also have reported resistance and have suggested either rotating the Tuohy needle or injecting saline solution. The reason for this resistance is unclear, but it may reflect the limited size of the thoracic paravertebral space or the catheter being impeded by the endothoracic fascia.

We also found blood-stained fluid in the catheter
aspirate in 4 of 15 cases, which we could flush clear with saline solution, indicating that the catheter was not intravascular. In patients without MFR, blood is seldom aspirated, the reported incidence of vascular puncture being 3.8%. Thus, we believe that this increase in incidence represents free blood tracking back from the fracture site.

In the series by Gilbert and Hultman, TPVB was performed by a single-shot percutaneous technique, with a mean (SD) dose of 25 mL (5 mL) bupivacaine 0.5% being injected, which provided analgesia lasting for a mean duration of 9.9 h (1.2 h). They needed to repeat the block in 7 of the 10 patients studied. They justified the use of a repeated single-shot TPVB, instead of a continuous technique, because the block was easy to perform. In contrast, when using a continuous technique, we were able to provide continuous pain relief with a sustained improvement in respiratory parameters and oxygenation throughout the 4-day study period.

A segmental contralateral block was present in three of our patients (Fig 1). Lönnqvist et al reported a lower incidence (1.1%). The exact etiology of this contralateral spread is not known but may be attributable either to epidural spread or to prevertebral spread to the contralateral paravertebral space.

Hypotension is a common occurrence after thoracic epidural anesthesia. In contrast, following TPVB hemodynamic stability was maintained in all our patients. Hypotension is unlikely to follow TPVB in normovolemic patients because of the unilateral nature of the sympathetic blockade. However, TPVB may cause hypotension in the inadequately resuscitated and hypovolemic patient. Therefore, we agree with Gilbert and Hultman that patients should not be offered TPVB unless they have been adequately resuscitated and cardiovascular stability has been established for several hours.

In one of our patients, a bilateral symmetrical block with accompanying hypotension indicative of
an epidural block developed. This is rarely reported following TPVB but may occur due to extensive epidural spread, injection via a medially directed needle, inadvertent injection into a dural sleeve, or if an excessively large volume of local anesthetic is used. However, we injected relatively small bolus volumes of local anesthetic via the indwelling paravertebral catheter. Furthermore, an inadvertent intrathecal injection was unlikely because of the absence of motor blockade. Therefore, we must conclude that extensive epidural spread must have occurred. Some minor degree of epidural spread has been reported after 70% of TPVBs. However, this is usually unilateral, the volume involved being small, and somatic and sympathetic nerves are blocked unilaterally. When radiopaque contrast medium is injected into the thoracic paravertebral space, it produces a typical longitudinal or
cloud-like spread of contrast medium that is localized to the paravertebral region, as seen on anteroposterior chest radiographs.\(^6,19\) In case 9, the lack of this thoracic paravertebral spread and the preferential epidural spread of contrast medium (Fig 2) suggested an epidural rather than paravertebral injection.

Despite using a high infusion rate of bupivacaine (20 mg/h) for 4 days, none of our patients exhibited clinical signs of local anesthetic toxicity. Currently, there are no published data on the pharmacokinetics and possible toxicity of bupivacaine in patients with MFR who are receiving TPVB. However, systemic toxicity appears to be rare during continuous TPVB,\(^2\) despite the use of higher amounts of bupivacaine than that used in our series.\(^2,8\) Although the total bupivacaine plasma level steadily increased in surgical patients receiving postoperative infusion, the free bupivacaine level remained unchanged.\(^20\) A postoperative rise in \(a\_1\)-acid glycoprotein, which binds to the bupivacaine, appears to offer protection against toxicity.\(^20\) The same may be true in patients with MFR due to trauma.\(^31\)

Other than aberrant blockade, one inadvertent epidural injection, and one instance of Horner syndrome, there were no other major complications of TPVB in our series. However, due to the limited sample size (15 patients), we were unable to draw any definite conclusions about clinical safety. Published data would suggest that the complication rate is low (2.6 to 10%).\(^11,22\) Lönnqvist et al\(^11\) evaluated 367 paravertebral blocks, both thoracic and lumbar, and found the following rates: vascular puncture, 3.8%; hypotension, 4.6%; pleural puncture, 1.1%; and pneumothorax, 0.5%. Inadvertent pleural puncture may not necessarily result in a pneumothorax and is usually managed conservatively.\(^2\) Other rare complications include inadvertent intravascular injection, pulmonary hemorrhage, spinal anesthesia, postural headache, and intercostal nerve trauma.\(^2\)

No fatality from TPVB has yet been reported.

We conclude that continuous thoracic paravertebral infusion of bupivacaine is a simple and effective method of providing continuous pain relief in patients with unilateral MFR. Patients also enjoy sustained improvement in respiratory parameters and oxygenation.

ACKNOWLEDGMENTS: The authors thank Marlene Ma, BHSc, Pain Nurse, and Raymond Chung, MPhil, Research Assistant from the Department of Anesthesia and Intensive Care at the Prince of Wales Hospital, The Chinese University of Hong Kong, for their contributions.

FIGURE 5. The mean (SEM) values for systolic arterial pressure (SAP), diastolic arterial pressure (DAP), and heart rate (HR) following the commencement of TPVB in patients with MFR. No significant changes were seen over the first 30 min after the paravertebral injection.

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