Pain relief after thoracotomy: is epidural analgesia the optimal technique?

Thoracotomy is often performed in patients with pre-existing lung disease such as lung cancer and chronic obstructive pulmonary disease. It is associated with the potential for severe pain, further impairment of lung function, delayed recovery and the occurrence of chronic pain.1–3 The provision of pain relief is a major consideration and thoracic epidural analgesia is often regarded to be the gold standard. However, epidural analgesia is not always ideal and other useful regional methods of analgesia after thoracotomy have been proposed. This editorial illustrates some of the reasons for severe pain after thoracotomy and shows that there are alternatives to epidural analgesia.

To understand why thoracotomy is associated with much pain and thus the necessity for high-quality analgesia, it is important to understand the pathophysiology of tissue damage.

- Rib retraction and intercostal nerve damage. During thoracotomy, the lateral chest wall is incised, tissue dissected, and a retractor placed in an intercostal space to separate adjacent ribs thus enabling the surgeon wide access. In a rat model mimicking this situation, it has been suggested that intercostal nerve damage may occur as a result of the rib retractor. In a study of rats, a thoracotomy incision and retractor were compared with controls with a thoracotomy incision down to the pleura but with no retractor.4 Mechanical and cold allodynia were observed in 50% of the rats in which a retractor was in place for 60 min. On histology, there was degeneration and minimal re-myelination in rats with allodynia. These positive findings contrast with those of the controls and also with rats in which a retractor was placed for only 5 and 30 min.

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13 Bernal W, Wendon J. Comparison of patients with paracetamol-induced hepatotoxic effects receiving human albumin solution or hydroxyethyl starch. Lancet 2001; 358: 583
• **Intercostal nerve damage and type of thoracotomy.**

Thoracotomy by a standard postero-lateral approach is likely to be associated with greater intercostal nerve damage and pain than by muscle-sparing thoracotomy. In a study of 24 patients for overall intercostal nerve damage, the electromyographic amplitude of superficial reflexes in the upper abdomen was significantly lower, 1 month after postero-lateral thoracotomy than after muscle-sparing thoracotomy. Denervation of the incisional scar was assessed by measurement of somato-sensory evoked potentials, which were significantly reduced in patients who received postero-lateral thoracotomy compared with those who had a muscle-sparing procedure. It has also been found that thoracotomy was associated with hyperalgesia and hyperesthesia along the incision. These were significantly greater after postero-lateral thoracotomy than after muscle-sparing thoracotomy.

• **Intercostal nerve damage and closure of thoracotomy with pericostal sutures.** The usual practice of closure of a thoracotomy incision is pericostal (i.e. sutures are placed over the fifth rib and also over the top of the seventh rib). This technique is thought to contribute to intercostal nerve damage and hence acute and chronic pain after thoracic surgery. An alternative method is to place the lower sutures through holes drilled in the body of the sixth rib rather than over the top of the seventh rib. Compared with pericostal closure, intracostal placement of sutures has been reported to be associated with significantly less pain at 2 weeks and 1, 2 and 3 months after thoracotomy.

Epidural analgesia is commonly provided for analgesia after thoracotomy and has been said to be more effective than intercostal, interpleural, and i.v. opioid analgesia in clinical studies. In a randomized controlled trial (RCT) comparing epidural analgesia with i.v. morphine, postoperative pain intensity scores at rest, on coughing, and on movement were significantly lower in patients who received a combination of epidural bupivacaine 0.1% and morphine 0.05–0.1 mg ml\(^{-1}\). The incidence of pain at 2 and 6 months in the epidural group was significantly lower than that in the i.v. morphine group, inferring that epidurals may be effective for prevention of chronic pain after thoracotomy.

During thoracic surgery, it is possible that surgical manipulation and trauma may occur to cardiac parasympathetic nerves, causing a sympathotonic state. Thus, the sympathetic block obtained from an epidural-containing concentrated local anaesthetics may be beneficial. Indeed, in a RCT, the incidence of atrial fibrillation and paroxysmal supraventricular tachycardia was significantly lower in patients who received epidural bupivacaine 0.25% than in those who had epidural morphine.

Thoracic epidurals have also been shown to be as efficacious for analgesia as paravertebral block. In a recent meta-analysis of 10 RCTs that included 520 patients, pain scores and rescue morphine consumption in both groups were similar. However, epidurals were associated with significantly higher adverse effects such as block failure, hypotension, urinary retention, pulmonary complications, and nausea than paravertebral analgesia. These outcomes may, in part, be explained by knowledge of differences between the two methods of analgesia:

• Block failure was more likely in patients receiving an epidural than paravertebral block probably because of difficulty with epidural insertion in the thoracic spine and greater success with placement of a paravertebral catheter under direct vision during thoracotomy.

• The bilateral sympathetic, sensory, and motor block of epidurals may explain the occurrence of hypotension, urinary retention, and pulmonary complications. In patients receiving unilateral analgesia from paravertebral block, there may be preservation of these functions and hence maintenance of blood pressure, bladder function, and respiratory effort on the contra-lateral side.

• The higher incidence of nausea in patients receiving an epidural may be related to hypotension and also to the differences in solutions administered. Both techniques require the initial administration of concentrated local anaesthetics (e.g. bupivacaine 0.25–0.5%). However, background epidural infusions often contain opioids that are associated with concentration-dependent nausea. Paravertebral infusions, however, do not contain opioids (e.g. bupivacaine 0.25% at 0.1 ml kg\(^{-1}\) h\(^{-1}\)).

Because of its central location, there is potential danger associated with instrumentation of the epidural space. There has been much debate over the timing of epidural insertion (i.e. should epidurals be inserted awake rather than under general anaesthesia to minimize the risk of neurological sequelae?) This safety issue is not a feature of paravertebral analgesia, because the paravertebral space is located lateral to the vertebral column.

In patients who have a coagulopathy, epidural insertion may be contraindicated because of the risk of spinal haematoma and cord compression. However, effective regional analgesia using the paravertebral space is possible as it is more distensible than the epidural space. The safety of this technique may be optimized provided catheter insertion is performed under direct vision at the time of thoracotomy. Despite this difference, contraindications to both epidural and paravertebral analgesia include infection at the site of the needle, empyema, and allergy to local anaesthetic drugs.

Effective thoracic epidural analgesia for pain in the dermatomal distribution of their thoracotomy may be associated with severe ipsilateral shoulder pain in the initial post-operative period. This pain is thought to be referred and related to nociceptive conduction in the phrenic nerve as a result of tissue trauma to the mediastinum, diaphragm,
and pericardium. This has only been reported in studies of thoracic epidural analgesia, but it would not be surprising if ipsilateral shoulder pain also occurs in patients receiving paravertebral block.

Lumbar spinal opioid analgesia is an alternative to thoracic epidural analgesia. Studies have been performed with preservative-free morphine, sufentanil, and fentanyl.\(^{19}\) Morphine has a slower onset but longer duration of action than fentanyl and sufentanil. In a RCT of 30 patients, a combination of intrathecal morphine 200 µg with sufentanil 20 µg was found to be associated with significant reduction in pain intensity at rest and on coughing, for approximately 24 h, compared with placebo.\(^{20}\) The mean (sd) i.v. rescue morphine use in the first 24 h was 36 (15) mg in the placebo group which was significantly higher than that of the intrathecal opioid group 18 (15) mg. No difference in spirometry was detected between the two treatment groups.

Higher doses of intrathecal opioids, morphine 500 µg, sufentanil 50 µg and their combination, were studied in patients with postero-lateral thoracotomy.\(^{20}\) Compared with placebo, pain scores at rest and on coughing in patients receiving sufentanil were significantly lower in the first 4 h. In morphine and combination groups, pain scores at rest and on coughing were significantly lower than in the placebo group, for 10 and 8 h respectively. The mean (sd) rescue 24 h morphine consumption of 38 (31), 46 (34) and 23 (16) mg in patients receiving morphine, sufentanil, and their combination, respectively, were significantly lower than that of 71 (30) mg in the placebo group.

Pain is most severe within the first postoperative day and intrathecal opioids seem to be efficacious for analgesia during this time. However, intrathecal opioids are not without adverse effects, and in a 7-yr period involving 5969 patients, pruritus, nausea, and respiratory depression occurred in 37, 25, and 3%, respectively.\(^{19}\)

There is probably no ideal single regional technique for pain relief after thoracotomy: epidurals, paravertebral block and intrathecal opioids, each has advantages and disadvantages. Patients should have reliable, effective dermatomal analgesia without ipsilateral shoulder pain, hypotension, urinary retention, pruritus, and nausea. Improvements in epidural analgesia have been described in studies using combined solutions containing low-concentration local anaesthetics with adjuncts such as fentanyl and epinephrine at an optimal concentration.\(^{22}\) Administered in this way, effective epidural analgesia may be obtained with some reduction in adverse effects caused by individual solutions of high drug concentration.

An alternative, method is a combination of low-dose intrathecal morphine with paravertebral analgesia. Intrathecal analgesia is effective in the immediate post-operative period. This period may be extended by paravertebral block via a catheter placed under direct vision during thoracotomy.\(^{23}\) This combination is likely to be associated with minimal risk of hypotension and hence use of excessive fluids that should be avoided in patients with borderline lung function. As paravertebral block is unilateral rather than bilateral, there may be less risk of motor block and urinary retention, thus facilitating mobilization and recovery. There may also be reduced risk of the rare but devastating complication of epidural haematoma or abscess.\(^{24}\) In conclusion, epidurals are useful for pain relief after thoracotomy and will continue to be used by many anaesthetists. However, an alternative approach would be a bimodal method comprising intrathecal morphine and paravertebral block.

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