Analgesia After Thoracotomy — The Role of the Extrapleural Paravertebral Catheter

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"This great little block is so easy that you can even train a surgeon to do it! I much prefer, however, to scrub in and do it myself, or get my registrar to 'see one, do one' and someday teach one."

An extrapleural paravertebral catheter sits longitudinally in the potential space between the parietal pleura and the ribs posteriorly about five centimetres from the midline. It can be positioned under direct visualisation at thoracotomy so that a pocket of local anaesthetic (LA) overlies the relevant nerves and that the catheter is in the correct plane and is not in a vessel. The block has been used to provide unilateral analgesia after adult thoracotomy since the late 1980s.

In 1997, a series of these blocks in children was reported.[1] Since then, further research has made this a mainstay for postoperative analgesia after paediatric and neonatal thoracotomy, avoiding some of the risks of thoracic epidural anaesthesia (TEA) in the anaesthetised child. It has also proven to be an extremely effective form of analgesia, with minimal complications in adults.[2-6] Indeed, the available evidence supports the claim[7] that it is the most desirable technique currently available for providing regional anaesthesia for the post-thoracotomy patient.

Nomenclature

There is great variation in the nomenclature used in the literature for this technique of pooling LA in the paravertebral space. Different approaches to the space are also described, with or without the use of a catheter; this has led to several different terms being used to describe the same blockade. Continuous extrapleural intercostal nerve blockade (CEINB), retropleural block, and paravertebral block have all been used. It will be referred to here as "extrapleural paravertebral block".

Anatomy

The vagus and phrenic nerves carry some afferent sensation, but the predominant afferent pathways for central conduction of nocioception following lung surgery occur via the following nerves:

- anterior primary rami — incisional pain, chest wall and most of the parietal pleura
- posterior primary rami — retraction pain from posterior spinal muscles and costo-vertebral ligaments
- sympathetic nerves — visceral nocioception from visceral pleura and lungs.

The site of the block determines which of these structures can be anaesthetised (Table 1).

Table 1

Effect of different regional techniques on relevant pain transmitting pathways

Technique used	Posterior rami	Anterior rami	Sympathetics
Thoracic epidural analgesia	Bilateral	Bilateral	Bilateral — may cause BP drop
Extrapleural paravertebral block	Ipsilateral	Ipsilateral	Ipsilateral — BP is stable
Intercostal nerve block	Not blocked	Ipsilateral	Not reliably blocked

The intercostal nerve

The anterior primary ramus forms the intercostal nerve which then travels laterally with the intercostal artery and vein. It sits within a sheath which is thinner in its early paravertebral course, allowing more ready penetration by LA. The traditional approach to intercostal nerve blockade is at the angle of the rib. At this distance from the midline, the sympathetic chain, and dorsal ramus of the intercostal nerve are not reliably blocked. This leads to inferior analgesia when compared to extrapleural paravertebral blockade. Additionally, only one level tends to be blocked due to adherence of the pleura to the rib, effectively separating off each level. For this reason, intercostal nerve blocks lateral to the angle of the rib require injections at multiple levels. However, medial to the angle of the rib, the pleura is less adherent, enabling LA deposited at one level to spread cephalad and caudad with ease, potentially blocking nocioception from the three pathways from all surgically affected dermatomes (Figure 1).

The extrapleural paravertebral space

The extrapleural paravertebral space is a wedge shaped area between the heads and necks of the ribs.[8] It is a potential space that is easily created by fluid distension. The space is continuous with the epidural space medially and the neurovascular space beneath each rib laterally. The boundaries of the space are described in Table 2.

The space contains the following neurological structures:

- spinal nerve, dividing into the rami
- rami communicantes (white and grey)
- sympathetic chain.

As mentioned, the placement of LA extrapleurally, medial to the angle of the rib, is more likely to spread to multiple levels than an intercostal nerve block at or lateral to the angle of the rib. The major mechanism of spread of LA over several intercostal levels, and hence analgesia over multiple dermatomes, is via the paravertebral space.[1,8] Hence, a catheter that is placed longitudinally along this space is ideally situated to provide a continuous pool of agent to bathe multiple intercostal nerves and the ipsilateral sympathetic chain (Figures 2 and 3).

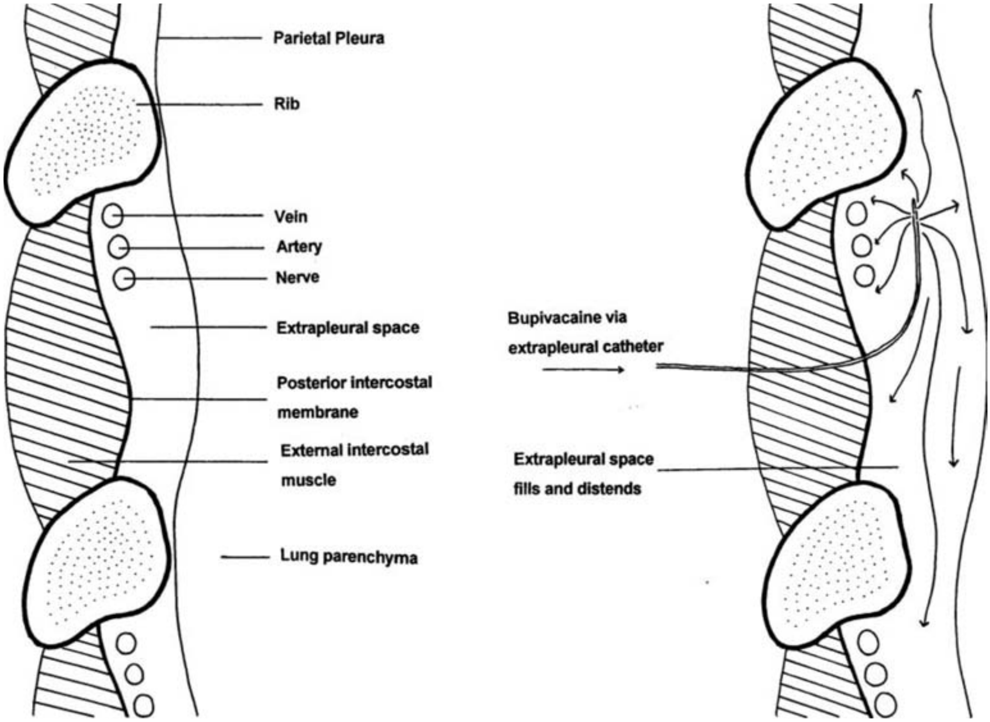

Figure 1. The potential space is expanded with local anaesthetic which forms a pocket to bathe the nerves (from AIC 1997 with permission from authors).

Table 2
Boundaries of the extrapleural paravertebral space (adapted from Richardson, 2004)[7]

Boundary	Structures
Posterior	• Superior costotransverse ligament • Posterior intercostal membrane (this is the medial continuation of the internal intercostal muscle)
Anterior	• Parietal pleura — this must be intact to form the anterior boundary of the extrapleural space and prevent spillage of LA to the interpleural space
Medial	• Vertebra • Intervertebral disc • Intervertebral foramen — LA may track through the foramen and produce epidural analgesia
Lateral	• No limit — the paravertebral space is continuous with the intercostal space
Inferior	• Sacrum
Superior	• Occiput

Mechanism of action

Distending the extrapleural paravertebral space with LA to bathe the above structures leads to direct blockade of all relevant pain fibres. These nerves are within the same tissue plane as the extrapleural paravertebral catheter and, in this location, the intercostal nerve has only a thin membranous sheath allowing easy penetration by LA.[7] An undetermined portion of the effect may be due to epidural spread in some patients. Although the block is almost always unilateral, we have occasionally seen

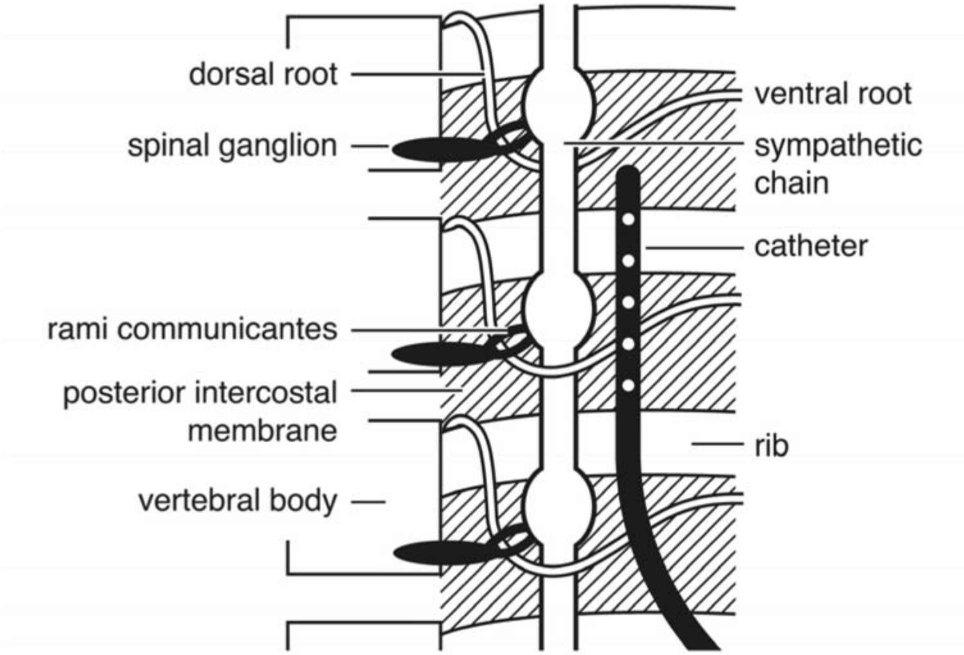

Figure 2. Correct position of a left sided extrapleural paravertebral catheter.

patients with a patch of numbness on the opposite side, perhaps due to epidural spread or extrapleural spread across the front of the vertebral body.

When can it be used?

Extrapleural paravertebral block has been successfully used for thoracotomy procedures in a wide range of patients. It has been successfully used in pneumonectomy, spinal surgery patients and bilaterally, for bilateral thoracotomy and can be adapted for surgical placement when performing video assisted thoracoscopic surgery (VATS). All that is required is that the parietal pleura covering the vertebral bodies and a few lateral centimetres are left intact,[7] and that this pleura is not pathologically adherent to the rib due to infection or fibrosis.

As mentioned earlier, it is suitable for use in children, for whom it has been repeatedly demonstrated to provide excellent analgesia and minimise opioid requirements with a very high safety profile. Cheung[9] studied neonates with a median age of 1.5 weeks and found the technique easy, effective, and without complication.

Evidence for its use post-thoracotomy

The outcome measures in comparing different analgesic techniques post-thoracotomy are:

- visual analogue scores, particularly with respect to coughing or movement (dynamic analgesia)
- total opioid consumption
- preservation of preoperative pulmonary function.

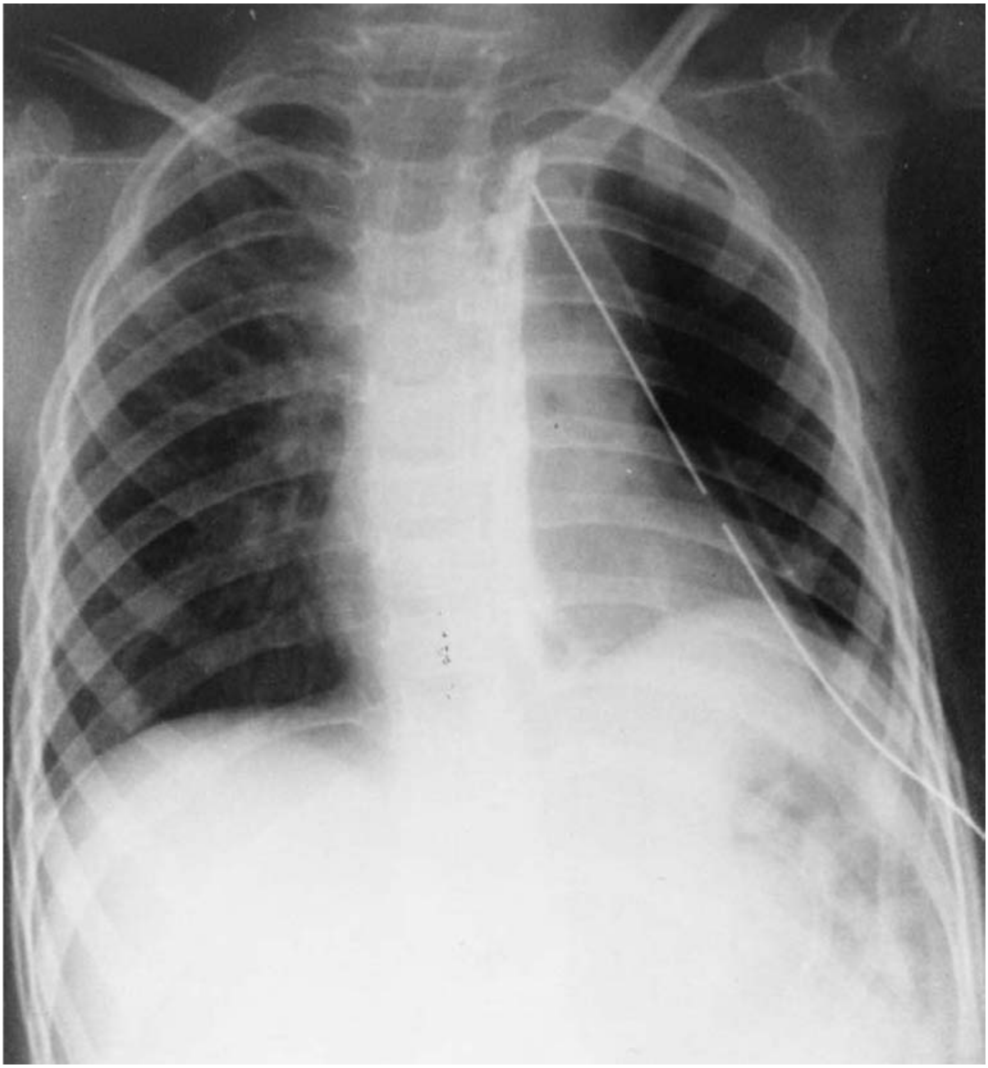

Figure 3. X-ray of a child after contrast was injected down a left extrapleural catheter. (From AIC 1997 with permission from authors.)[1] Note: The catheter itself cannot be seen through the contrast. The LA pocket has its upper extremity at the level of the clavicle. There is a left sided chest drain.

With respect to these features, clear advantages of extrapleural paravertebral block have been demonstrated over systemic opioids, and interpleural analgesia.

There are eight randomised studies comparing epidural (TEA) with extrapleural paravertebral blockade.[6, 11-18] These are summarised in Table 3. Several of these studies have demonstrated a benefit with the paravertebral technique over TEA either in terms of analgesia, particularly after day one, and/or a significant reduction in side effects.[6, 11, 14-16] Preservation of spirometry with extrapleural paravertebral infusions is superior to that of TEA.[16, 18] In 1999, Richardson[18] reviewed 55 studies of post-thoracotomy analgesia where perioperative spirometry had been measured. This involved 1762 patients. The most effective analgesic method in terms of preservation of spirometric function was the extrapleural paravertebral technique, with an approximate 75% preservation of preoperative values. This compared to 50-55% with TEA or intercostal blocks. In addition to these randomised studies, many authors have documented safety, ease of insertion and maintenance, and high quality analgesia in case series of extrapleural paravertebral block.

Table 3
Randomised trials comparing epidural with extrapleural paravertebral blockade for post-thoracotomy analgesia

Author	No. of patients	Group A Epidural	Group B Extrapleural	Outcome
Matthews[11] 1989	20	Bup 0.25%	Bup 0.25%	Equivalent analgesia Group A — more hypotension and urinary retention
Richardson[6] 1993	20	Morphine	Bup 0.25%	Pain, lung function same. Group A ↑ side effects
Perttunen[12] 1995	45	Bup 0.25% 4-8 ml/hr	Bup 0.25% 4-8 ml/hr	Equivalent VAS, opioid use, respiratory function
Dauphin[13] 1997	61	Morphine 7 micro/kg	Bup 0.5%+Adr 0.1 ml/kg/hr	VAS same Bup levels not toxic after 5 days
Kaiser[14] 1998	30	Bup 0.375% and fent. 2 microg/ml at 4-8 ml/hr	Bup 0.5% 0.1 ml/kg/hr	Equivalent VAS, opioid use, respiratory function Group A ↑ side effects B more practical
Bimston[15] 1999	50	Bup 0.1% and fent. 10 microg/ml at 10-15 ml/hr	Bup 0.1% and fent. 10 microg/ml at 10-15 ml/hr	Group A better VAS first 24 hrs, then no difference Group A ↑ side effects Note low concentration of Bup.
*Richardson[16] 1999	100	Bup 0.25% 0.1 ml/kg/hr	Bup 0.5% 0.1 ml/kg/hr	Group A — worse VAS and resp function. ↑ side effects: N&V, hypotension, urinary retention
**Debreceni[17] 2003	47	Bup 0.25% 5-10 ml/hr	Bup 0.25% 5-10 ml/hr	Group A better VAS first 12 hrs, then no difference. Same opioid use, and lung function

Bup=Bupivacaine (used in all the above studies); VAS=visual analogue scale.
All studies preceded their extrapleural infusions with a bolus of bupivacaine, usually 0.25% or 0.5%, 0.3 ml/kg.
*Note no opioid was used in the epidural solution.
**The catheter position in this study was between the internal and external intercostal muscles, not between the parietal pleura and the posterior intercostal membrane as is recommended.

None of these studies directly compares the use of TEA ropivacaine and fentanyl to extrapleural paravertebral infusion of LA. In our experience in adults, an effective extrapleural block with ropivacaine 0.2% does not provide quite as good analgesia as a TEA; however, ropivacaine 0.375% produces excellent analgesia and may carry a lower risk than TEA.

Technique of placement of the extrapleural paravertebral catheter

Different techniques are described in the literature, but there is no consistent nomenclature. Here they will be discussed in terms of anaesthetic style, surgical style or blind percutaneous placement (chest closed). The desired catheter position is the same with each.

Anaesthesia style of placement — direct visualisation

The catheter is inserted percutaneously by a scrubbed anaesthetist or surgeon using a Tuohy needle under direct visualisation of the parietal pleura, just before closure of the thoracotomy wound. The ideal skin entry point is two intercostal spaces below the level of the thoracotomy and about five centimetres from the midline posteriorly (in an adult). As the tip of the Tuohy needle is seen to enter the potential space beneath the parietal pleura, the stylet is removed and LA is injected. This raises a bleb under the parietal pleura which, after 10 to 20 ml (again, in an adult) forms a pocket extending several levels above and below the surgical level and separate from the thoracotomy incision. The catheter is then fed into this newly formed pocket in a cephalad direction. This anaesthetises the relevant nerves and provides analgesia for emergence from the general anaesthesia.

Intra-operatively, additional NSAID, tramadol and/or opiate are usually given to help cover pain from the chest tube. These are also prescribed for regular analgesia in the postoperative period, as described in Appendix I.

This is our preferred technique of placement. The doses and volumes of LA required are summarised in Appendix II, and some “tips and tricks for the novice” have been included in Appendix III.

Surgical placement — direct visualisation

This technique refers to the creation of a local anaesthetic pocket by peeling back the pleura at the posterior edge of the thoracotomy wound as far medially as the sympathetic chain and inserting the catheter into this space. Often a Tuohy needle and a separate percutaneous skin entry posterior to the thoracotomy incision are used to site the catheter in the space. This is performed by the surgeon at open thoracotomy and involves placement and confirmation of the catheter position under direct vision. The pleura may then be tacked back down to separate the pocket of LA from the surgical wound and reduce spillage of LA to the interpleural space. Because of this step, this technique is more time consuming than the anaesthetic technique outlined above. This method was first described in a case series of 81 patients in 1988.[8]

Surgeons who have left the pleura open have found the analgesia comparable to that of epidural,[3] whereas closing the pleura by suturing it back down to form the local anaesthetic pocket, results in superior results and decreased LA requirement.[7] Despite closing the pleura between the LA pocket and the posterior edge of the thoracotomy wound, some LA may still be lost into the interpleural space and through the chest drain. This loss may not only increase dose requirements, but can also result in pooling on the diaphragm and impair function.

Blind percutaneous placement

The catheter may be placed blindly preoperatively, with subsequent confirmation and/or adjustment of position by the surgeon at thoracotomy. This might be done if analgesia prior to incision is desired but it is more time consuming and carries a failure rate of 6%,[19] much higher than if the catheter is positioned under direct vision. If this technique is used then confirmation of position by visualisation should be performed where possible. This blind approach also carries a pneumothorax risk of 0.5%,[19] not desirable just prior to induction of anaesthesia. We do not recommend this technique as one must weigh these risks against the unproven benefit of pre-emptive analgesia.

Which approach to use?

The balance of risk, benefit and effective time management favours placing the catheter under direct vision just prior to wound closure and using the anaesthetic style of insertion. This provides a pocket of LA overlying the relevant nerves and separate from the incision, so that the agent does not spill into the interpleural space. This approach is more rapid and more accurate than others and reduces the potential for complications.

Advantages of the technique

Unilateral blockade

As it only affects the ipsilateral nerve roots and sympathetic chain, a continuous unilateral blockade minimises depression of normal chest wall function, hypotension and urinary retention.[3,5] Indeed, it is unnecessary to monitor specifically for the cardiovascular changes and motor block seen with epidural analgesia.[7]

Ease and safety of insertion

The catheter is remarkably quick and easy to place, with the only potential obstacle being the presence of scarring in the paravertebral space. It is placed under direct vision in the open chest with the patient anaesthetised, ensuring accurate placement and minimal risk of morbidity. These factors are an improvement over TEA. The concern of spinal cord damage from epidural catheter placement is also avoided. Because of the safety of insertion, there is no asleep vs awake dilemma, intravascular catheterisation is unlikely and haematoma formation will be reduced. If it does occur, the consequences are of less significance, as the spinal cord is not in immediate proximity. There are no issues with timing of perioperative DVT prophylaxis. No major complications have been described after 16 years of use.

Blocks relevant nerves

There is blockade of the anterior and posterior rami of the spinal cord and the sympathetic chain. A bolus is given intraoperatively, and the infusion of LA is able to be titrated to response. This may be continued for several days. The dose or rate of infusion may be decreased after day two as pain decreases.

Simplified postoperative care

There is no requirement for postoperative high dependency care, which may be considered necessary in the epidural patient. No additional nursing skills or observations are required. Aseptic changing of syringes is all that is mandatory. Hypotension is not as common as with TEA, due to the unilateral block.

Patients maintain adequate ventilation and good cough effort

This enables a strong capacity to comply with postoperative physiotherapy and reduces pulmonary complications. The patients are actively encouraged to mobilise fully. There is an approximate 50% reduction in preoperative lung function with TEA, in comparison to extrapleural paravertebral block, which results in only a 25% reduction.[7]

Inexpensive

These patients are managed on the regular post-surgical ward, with less risk of hypotension. This significantly reduces intensive care admissions resulting in major cost savings.

Potential problems/complications with the extrapleural paravertebral catheter

Abnormal paravertebral space

The only absolute contraindications to the use of this block are localised sepsis, such as empyema, and tumour within the paravertebral space. Scarring within the paravertebral space will lead to failure of spread of LA and failure of intercostal nerve blockade. We have found that patients with previous CABG frequently have fibrosis in the paravertebral space and the technique is often unsatisfactory in this group. Of course, if there is no remaining intact pleura to form an anterior limit to the space, the block cannot be effective.

Potential for local anaesthetic toxicity

LA toxicity has never been reported with this technique, and several authors have found that the plasma concentrations have remained below toxic thresholds even after five days of infusion.[4,9] In fact, there is a greatly reduced risk of causing LA toxicity when compared to TEA, because the catheter is placed under direct vision and the initial bolus is known to be in the correct plane and not in a vessel.

Inflammation and arterio-venous malformations within the paravertebral space could increase LA absorption.

Horner's Syndrome

A unilateral sympathetic block occurs and may be manifested by a Horner's syndrome, if spread to the cervical region has occurred. This is of no concern, but if troublesome to the patient, can be reversed by having the patient sit upright or by slowing the infusion rate.[1]

What drugs to use?

Any LA agent can be used. Bupivacaine and lignocaine are the most widely studied. Several authors have found that infusion of lignocaine produces a safe block with similar efficacy to longer acting agents, and have argued that there is no need to use the more expensive agents.[2] Adrenaline may lower absorption and serum levels of LA.

The initial bolus is important; 15-20 ml of 0.25-0.5% bupivacaine in adults produces acceptable levels. Bupivacaine 0.25% bolus and infusion used in infants with a median age of 5.3 weeks were also found to be satisfactory.[20] Smaller neonates can also be safely given 0.5 ml/kg of 0.25% bupivacaine, with infusions often unnecessary. In adults continuous infusions have been found to provide better analgesia than single or repeated boluses.

There is very little data on ropivacaine in this application. However, it has become the most commonly used agent because of its low cardiotoxicity compared to bupivacaine. The ropivacaine doses we use are extrapolated largely from epidural data. A study looking at ropivacaine blood levels after extrapleural paravertebral block would be helpful. An initial bolus of 0.5% 10-20 mls provides good distension of the space and can be followed by an infusion of 0.375% at 0.1 ml/kg/hr. These doses are outlined in Table 4. The use of 0.2% ropivacaine is usually satisfactory, especially in children, but will lead to adults having inferior analgesia compared to TEA. Hence, the higher concentration is recommended in adults, and will still provide safe analgesia. There are no case reports of LA toxicity with the recommended rate of infusion.

There is little data on adding adjuvant drugs to the local anaesthetic.

Table 4
Recommended dosing schedules[9, 10, 23]

	1. Adults		2. Paediatrics	
	Bupivacaine	Ropivacaine	Bupivacaine	Ropivacaine
*Loading dose	0.25-0.5%+Adr 10-20 ml	0.5% 10-20 ml	0.25% 0.3 to 0.5 ml/kg	0.2% 0.3 to 0.5 ml/kg
Infusion Day 0-1	0.25-0.5% at 0.1 ml/kg/hr	0.375% at 0.1 ml/kg/hr	0.25% at 0.1 ml/kg/hr or 0.125% at 0.2-0.3 ml/kg/hr, in smaller infants requiring larger volumes	0.2% at 0.1-0.2 ml/kg/hr
Infusion	Reduce dose or cease infusion after chest drains removed		Reduce dose or cease infusion after 48 hours	

*The loading dose needs to be of sufficient volume to raise a pocket of LA covering at least 2 ribs above and below the level of the thoracotomy incision; this varies with the individual and is usually about 0.3 ml/kg.

What of the alternative: thoracic epidural analgesia (TEA)?

TEA has been the most commonly used regional technique for analgesia after thoracotomy. There have been several large studies highlighting the excellent analgesia it offers, being demonstrably superior to PCA opioid alone. It has also been shown in some studies that measures of pulmonary outcome are significantly improved by epidural LA, although others have failed to demonstrate this. Additionally, there is a more rapid return to normal autonomic function with TEA, when compared to PCA. Others have found a reduction in chronic post-thoracotomy pain.

Despite its popularity, there is no randomised, controlled trial that clearly shows post-thoracotomy outcome is superior when TEA is used. A large meta-analysis of 9559 patients having central neuraxial blockade for all surgery, demonstrated a significant reduction in thromboembolic phenomenon, pneumonia, myocardial infarction, transfusion requirements, respiratory depression and death.[21] The inclusion of all surgical procedures and the failure of confirmation of these results by the widely quoted MASTER trial[22] makes it difficult to apply these findings to the thoracotomy group. Additionally, the positive findings were mainly derived from the subset of patients undergoing orthopaedic surgery, whereas no significant effects were found in the other procedure groups (urology, abdominal and thoracic).

In recent years, there has been a growing appreciation of TEA complications, of which several are potentially catastrophic. This has resulted in a growing reluctance to use TEA and a search for a safer technique. As discussed earlier, the evidence favours the extrapleural paravertebral catheter technique — it is equally well accepted by patients, provides equivalent analgesia, is cheaper, technically easier and has fewer complications (Table 5).

We are all familiar with the complications of TEA. It must be reinforced that the alternative technique of paravertebral extrapleural blockade, with a catheter placed

Table 5
Comparison of extrapleural paravertebral and thoracic epidural blockade

	Extrapleural Paravertebral	Thoracic Epidural
Unilateral blockade	Yes	No
Quality of analgesia	Excellent	Excellent
Preservation of respiratory function	Well preserved (75%)[7]	Preserved (50%)[7]
Nursing care	No extra requirements	HDU/ICU care Urinary catheter often required Itch, nausea and vomiting common problems
Insertion technique	Direct vision Simple Safe to place when anaesthetised	Blind placement Technical skill required Patient should be awake for placement
Complications	Very rare Horner's syndrome	Rare Hypotension may be problematic Catastrophic complications possible
Familiarity	Still unfamiliar to many	Widely used Popularity decreasing
Contraindications	Local/systemic sepsis Adherent or disrupted pleura	Local/systemic sepsis Anticoagulation

under direct vision in theatre under strict aseptic conditions, does not have these major complications. If an abscess or haematoma did eventuate in the paravertebral space, the consequences would not necessarily be as dire.

Conclusion

Both TEA and extrapleural paravertebral block provide high quality analgesia, clearly superior to intravenous opioids and other regional techniques. They both preserve pulmonary function. Side effect profiles and potential complications may favour the choice of the extrapleural paravertebral over the epidural catheter for analgesia after thoracic surgery.

A randomised trial comparing local practice of TEA (with ropivacaine 0.2% and fentanyl 2 microg/ml) and extrapleural paravertebral infusion of 0.375% ropivacaine would help to determine if these techniques are equivalent or not.

Summary

Continuous intercostal nerve blockade via an extrapleural paravertebral catheter is a technique with an inherent safety. It delivers excellent analgesia, comparable to TEA. The catheter is simple to position and its correct location can be confirmed under direct vision. It is safe to place in the anaesthetised patient and it does not necessitate specialised high dependency nursing. It is a technique that is appropriate in the vast majority of thoracotomy procedures, and there is no reason why it should not be more widely relied upon as the cornerstone of the analgesic plan in these patients. Supplementation with regular paracetamol, tramadol and/or NSAIDs and with break-through subcutaneous opioids available, will allow high-quality, low-complication analgesia to be delivered.

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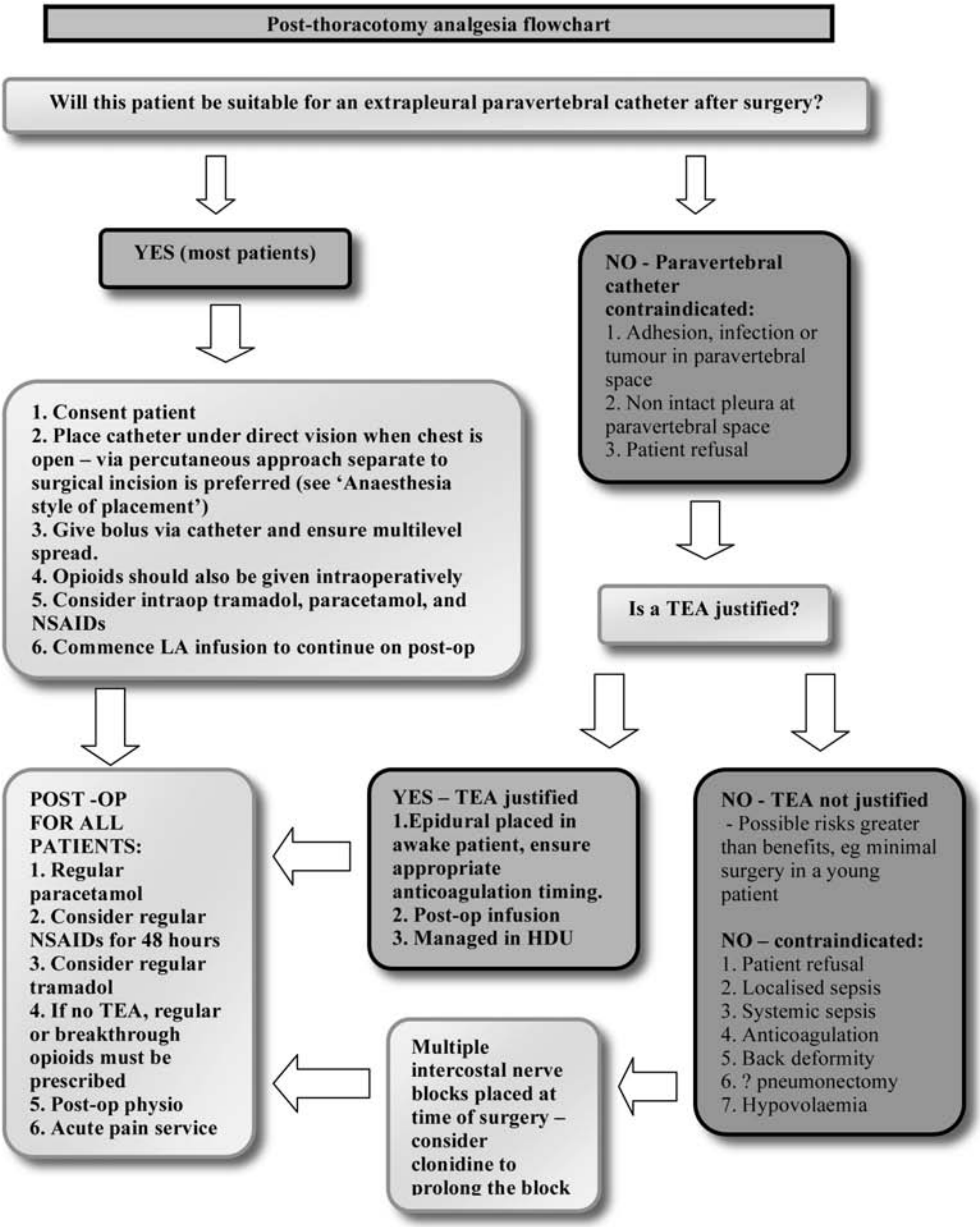
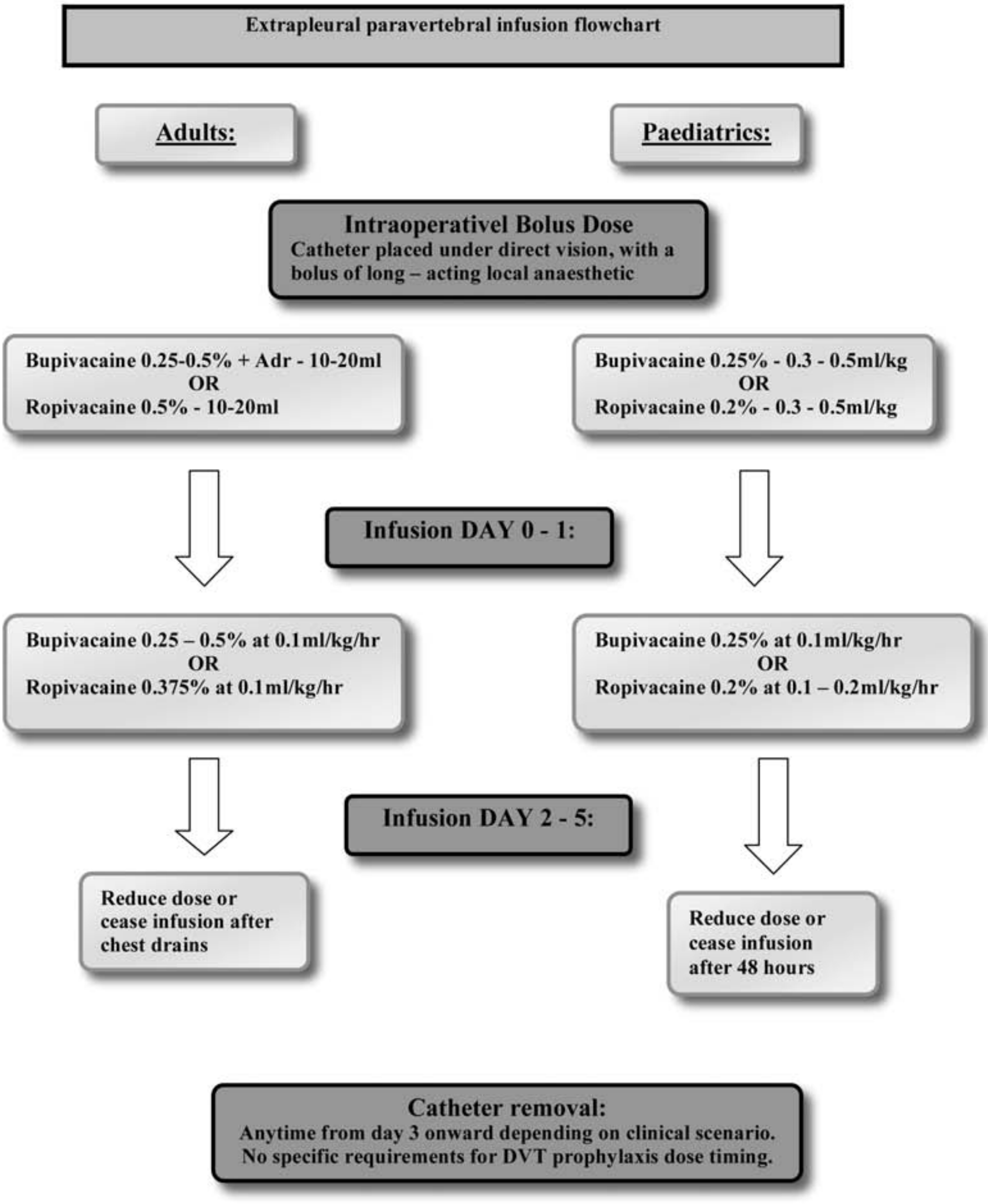
Appendix I


Post-thoracotomy analgesia flowchart
Will this patient be suitable for an extrapleural paravertebral catheter after surgery?
YES (most patients)
1. Consent patient
2. Place catheter under direct vision when chest is open – via percutaneous approach separate to surgical incision is preferred (see 'Anaesthesia style of placement')
3. Give bolus via catheter and ensure multilevel spread.
4. Opioids should also be given intraoperatively
5. Consider intraop tramadol, paracetamol, and NSAIDs
6. Commence LA infusion to continue on post-op
NO - Paravertebral catheter contraindicated:
1. Adhesion, infection or tumour in paravertebral space
2. Non intact pleura at paravertebral space
3. Patient refusal
Is a TEA justified?
POST -OP FOR ALL PATIENTS:
1. Regular paracetamol
2. Consider regular NSAIDs for 48 hours
3. Consider regular tramadol
4. If no TEA, regular or breakthrough opioids must be prescribed
5. Post-op physio
6. Acute pain service
YES – TEA justified
1.Epidural placed in awake patient, ensure appropriate anticoagulation timing.
2. Post-op infusion
3. Managed in HDU
NO - TEA not justified
- Possible risks greater than benefits, eg minimal surgery in a young patient
NO – contraindicated:
1. Patient refusal
2. Localised sepsis
3. Systemic sepsis
4. Anticoagulation
5. Back deformity
6. ? pneumonectomy
7. Hypovolaemia
Multiple intercostal nerve blocks placed at time of surgery – consider clonidine to prolong the block

Appendix II


Extrapleural paravertebral infusion flowchart
Adults:
Paediatrics:
Intraoperativel Bolus Dose
Catheter placed under direct vision, with a bolus of long – acting local anaesthetic
Bupivacaine 0.25-0.5% + Adr - 10-20ml
OR
Ropivacaine 0.5% - 10-20ml
Bupivacaine 0.25% - 0.3 - 0.5ml/kg
OR
Ropivacaine 0.2% - 0.3 - 0.5ml/kg
Infusion DAY 0 - 1:
Bupivacaine 0.25 – 0.5% at 0.1ml/kg/hr
OR
Ropivacaine 0.375% at 0.1ml/kg/hr
Bupivacaine 0.25% at 0.1ml/kg/hr
OR
Ropivacaine 0.2% at 0.1 – 0.2ml/kg/hr
Infusion DAY 2 - 5:
Reduce dose or cease infusion after chest drains
Reduce dose or cease infusion after 48 hours
Catheter removal:
Anytime from day 3 onward depending on clinical scenario.
No specific requirements for DVT prophylaxis dose timing.

Appendix III

Some practical tips and tricks for using the anaesthesia style of placement

- When the surgeons are prepping, ask them to drape back to the midline of the back; this gives you flexibility with your skin entry site.
- We always ask them if it's OK to scrub in at the end to site the catheter. After a few cases this becomes routine, but the surgeon will usually want to learn to do it themselves at some stage.
- Use a 16 gauge epidural kit for all but a small child.
- Ask for 5 minutes notice before they are ready to start closing, so you have time to scrub.
- Usually stand behind the patient; ask the surgeon to explain any anatomy you don't recognise.
- Palpate the ribs about 5 centimetres out from the midline (in an adult) and find the intercostal space 2 or 3 below the incision interspace.
- Taking the Tuohy needle enter the skin and pass between the ribs heading cephalad and slightly medial, keep the curved tip of the needle oriented toward the pleura. Remember that the intercostal vessels run in a groove under each rib so stay closer to the rib below.
- Looking inside the chest and advancing the needle slowly, you will see the curved tip of the Tuohy emerge into the potential space beneath the parietal pleura.
- If you perforate the pleura, don't fret! Remove the needle and change the angle slightly so the needle tip appears a few centimetres away from the perforation.
- Once the needle is under the pleura remove the stylet and inject some saline or LA to open the space.
- Some people like to burrow the Tuohy needle for a few centimetres under the pleura and then inject to raise the bleb.
- A good trick is to then feed the catheter into the space, connect some fluid to the other end and then inject up the catheter as you feed it cephalad.
- Some non-toothed forceps or a finger are handy to guide the catheter to stay parallel to the vertebral column
- Feed the catheter until the distal cm is seen a couple of spaces above the surgical interspace, the pocket of local anaesthetic should cover at least 6 intercostal spaces. This takes about 20 ml in an adult (0.3-0.5 ml/kg in a child). The skin marking will be about 15 centimetres in an adult.
- We usually then suture the catheter at the skin or tape well. Many a catheter has been lost with the careless removal of the drapes after closure so be watching and ready with a dressing.
- Tape it like an epidural and start an infusion in recovery at 0.1 ml/kg/hr (Appendix II).
- Check the block with ice in recovery. Leave it running for 3 days, or at least until the chest tubes are out. Bolus if needed as you would any nerve infusion.
- The first few you try will be a bit of a fiddle but please persist as once you get the knack, particularly the approach angle to the space, you will find it takes only a few minutes