# Epidural block

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# Epidural block[1]

VIRTUALLY all thoracic patients at the City Hospital have an epidural block unless this is contraindicated for some reason. Note the recent epidural 'best practice' publication (RCoA 2010). For history of the development of the epidural needle see Section **??**.


- RCoA (2010). *Best practice in the management of epidural analgesia in the hospital setting*. Faculty of Pain Medicine, Royal College of Anaesthetists, UK (November 2010)
- Ballantyne JC (2004). Does epidural analgesia improve surgical outcome? *Br. J. Anaesth.*; 92, 4–6. [answer: 'yes, but ... ']
- Desborough JP (1996). Thoracic epidural analgesia in cardiac surgery. *Anaesthesia*; 51, 805–807. [editorial]
- Gould TH, Grace K, Thorne G and Thomas M (2002). Effect of thoracic epidural anaesthesia on colonic blood flow. *Br. J. Anaesth.*; 89, 446–451.
- Howell CJ, Dean T, Lucking L, Dziedzic K, Jones PW and Johanson RB (2002). Randomised study of long term outcome of epidural versus non-epidural analgesia during labour. *Br. Med. J.*, 325, 357–359. [no difference in incidence of back-pain]
- Rigg JR, Jamrozik K, Myles PS *et al.* (2002). Epidural anaesthesia and analgesia and outcome of major surgery: a randomised trial. *Lancet*, 359, 1276–1282. [correspondence: *Lancet*, 360, 568–569.]
- Sielenkämper AW and van Aken H (2003). Thoracic epidural anesthesia: more than just anesthesia/analgesia? *Anesthesiology*; 99, 523–525. [neurophysiological effects & experiments in rats]


[1] `http://www.nickalls.org/dick/papers/thoracic/hand-epidural.pdf`

- Teoh DA, Santosham KL, Lydell CC, Smith DF and Beriault MT (2009). Surface anatomy as a guide to vertebral level for thoracic epidural placement. *Anesthesia and Analgesia*; 108, 1705–1707.
- Wheatley RG, Schug SA and Watson D (2001). Safety and efficacy of postoperative epidural analgesia. *Br. J. Anaesth.*, 87, 47–61.


## 2.1 Anatomy

Two excellent books on intercostal and epidural anatomy for anaesthetists are those by Mackintosh and Bryce-Smith (1953) and Mackintosh and Lee (1973). A convenient way of identifying the thoracic levels is to use the surface markings of the scapula; T2 = top border of scapula (*superior angle*); T5 = middle of scapula; T8 = bottom of scapula (*inferior angle*).

Since a typical thoracotomy incision follows the 5th rib, the aim is to locate the tip of the catheter at about T5 (middle of scapula). Inserting the Tuohy needle at the level T7–T8 (bottom of the scapula $\pm$ one space) generally works well.

For a thoraco-abdominal incision and also for an Ivor-Lewis operation, the tip of the epidural catheter needs to be at about T7 (middle of the range T4–T10). Consequently, inserting the Tuohy needle two–three spaces further down from the bottom of the scapula ($\pm$ one space) is generally satisfactory.


- Carnie J, Boden J and Gao Smith F (2002). Prediction by computerised tomography of distance from skin to epidural space during thoracic epidural insertion. *Anaesthesia*; 57, 701–704. [midline, T6–T9]
- Harrison GR and Clowes NWB (1985). The depth of the lumbar epidural space from the skin. *Anaesthesia*; 40, 685–687.
- Hoffmann VLH, Vercauteren P, Buczkowski PW and Vanspringel GLJ (1997). A new combined spinal-epidural apparatus: measurement of the distance to the epidural and subarachnoid spaces. *Anaesthesia*; 52, 350–355.
- Hogan QH (1998). Epidural anatomy: new observations. *Can. J. Anaesth.*; 45 (Suppl.), R40–R44. [part of the refresher course outline]
- Kao MC, Tsai SK, Chang WK, Liu HT, Hsieh YC, Hu JS and Mok MS (2004). Prediction of the distance from skin to epidural space for low-thoracic epidural catheter insertion by computed tomography. *Br. J. Anaesth.*, 92, 271–273. [paramedian approach only]
- Mackintosh RR and Bryce-Smith (1953). *Local analgesia: abdominal surgery*. (E & S Livingstone).
- Mackintosh RR and Lee JA (1973). *Lumbar puncture and spinal analgesia*, 3rd ed. (Churchill Livingstone). ISBN 0-443-00997-X

### 2.1.1 The epidural database (TEPID) [2]

Several studies have tried to correlate the depth of the epidural space from the skin with a *single* parameter (e.g., height, weight or BMI), but none has proved particularly useful (see references in Section 2.1). This suggests that using only a *single* parameter is probably the wrong approach. Consequently my TEPID database uses three parameters (height, weight and gender) and gives quite accurate predictions (560+ patients in the database). Although the TEPID database was started in order to serve as a guide to the depth of the epidural space, it was John Alfred Lee (1906–1989), who was sufficiently concerned about the depth that he introduced the standard 1 cm markings on the Tuohy needle (Section **??**) in order to try and reduce the number of inadvertent dural taps (Lee 1960; Maltby 2002).

The midline depth of the epidural space in the region T6–L3 decreases from above downwards, and is, typically, most superficial at the the L2/3 space. The TEPID data for an average male and female are shown in Table 2.1. The predictive value of paramedian data was poor, and consequently this is no longer collected or displayed.

Table 2.1:
TEPID data for midline epidural depths (cm). The epidural spaces are counted up ($-$ve) and down ($+ve$) from the bottom of the scapula (BS) in the lateral position (or sitting). The T7/8 space is generally level with the bottom of the scapula and is therefore defined as BS(0). In the UK the average male and female heights are approximately 5ft 9in (176 cms) and 5ft 4in (164 cms) respectively. The results are given as: `mean(SD)[range](n)`

| | average male<br>wt 76 ± 7·5 kg<br>ht 176 ± 7·5 cm | average female<br>wt 67 ± 7·5 kg<br>ht 165 ± 7·5 cm |
|---|---|---|
| BS(+0) T7/8 | 5·7(0·59) [4·5–6·7] (20) | 5·5(0·66) [3·7–7·0] (35) |
| BS(+1) T8/9 | 5·3(0·53) [4·5–6·5] (12) | 5·0(0·60) [4·0–6·5] (14) |
| BS(+2) T9/10 | 5·0(1·0) [4·0–6·5] (6) | 4·9(1·2) [3·5–7·0] (11) |
| BS(+3) T10/11 | 4·4(0·56) [3·5–5·2] (8) | 4·0(0·54) [3·0–5·0] (11) |
| BS(+4) T11/12 | — | 3·7(1·1) [3·0–4·5] (2) |
| BS(+5) T12/L1 | 4 (n=1) | — |

The TEPID database, together with a Perl program, is freely available. After entering the patient's height/weight/gender the program displays both the epidural data and the relevant tube data (single and double-lumen).

[2] Tube and EPIdural Database (TEPID). This is a collection of thoracic epidural and tube data accumulated over many years. It is freely available from http://www.nickalls.org/dick/xenon/rwdnXenon.html

- Lee JA (1960). Specially marked needle to facilitate epidural block. *Anaesthesia*; 15, 186. [cited from Maltby 2002]

- Maltby JR (2002). Lee's 'Synopsis of Anaesthesia' & Lee epidural needle; John Alfred Lee (1906–1989). In: *Notable names in anaesthesia.* (The Royal Society of Medicine Press Limited, London). p. 114–116. [ISBN 1853-155-128.]


## 2.2 General aspects

### 2.2.1 Awake or under GA?

There is currently some discussion regarding whether epidurals should be performed under GA or not (following a couple of reported cases from Germany of paraplegia following epidural under GA).


- Drasner K (2004). Thoracic epidural anaesthesia: asleep at the wheal? *Anesthesia & Analgesia*; 99, 578–579. [editorial]

- Fischer HBJ (1998). *Anaesthesia*; 53, 727–729. [editorial]

- Gruning T (1999). Regional anaesthesia—before or after general anaesthesia? *Anaesthesia*, 54, 86–87. [letter]

- Kao M-C, Tsai S-K, Tsou M-Y, Lee H-K, Guo W-Y and Hu JS (2004). Paraplegia after delayed detection of inadvertent spinal cord injury during thoracic epidural catheterization in an anesthetized elderly patient. *Anesthesia & Analgesia*; 99, 580–583.

- Wildsmith JAW & Fischer HBJ (1999). Regional anaesthesia—before or after general anaesthesia? *Anaesthesia*, 54, 86–87. [letter]


### 2.2.2 Midline approach

The midline depth of the epidural space appears to decrease from above downwards in the region T6–L3, probably being most superficial at the the L2/3 space. Data from our own thoracic database (TEPID; see section 2.1.1) for an average male and female are shown in Table 2.1.

### 2.2.3 Paramedian approach

The paramedian depth of the epidural space at T7–T8 is approximately 3–5 cms. Use the depth of the lamina as a guide: the epidural space is usually $\leq 2$ cm deeper than the lamina.

### 2.2.4 Reducing catheter migration / fallout

#### At the skin

Catheter fall-out rate is significantly reduced by (a) good strapping, and (b) leaving more catheter in the epidural space. I originally used to leave about 4–5 cm inside the epidural space but this was associated with a significant 'fall-out' rate during the first few postoperative days. Some years ago I therefore decided to experiment by having the 15 cm mark at the skin, and since then (a) none has 'fallen-out' as far as I am aware, and (b) no adverse effects have been noticed.

#### At the filter

A recent letter by Picton and Das (2004) described taping the catheter to the filter (including a small redundant loop of catheter) as a good method for reducing catheter disconnection at the filter. The problem of how to proceed if the epidural catheter itself becomes disconnected from the filter is addressed in Section 2.4.1.

- Picton P and Das S (2004). Decreasing epidural failure. *Anaesthesia*; 59, 729.

### 2.2.5 Radiographic placement

The following two reports describe a paramedian radiographic technique for locating the tip of the Tuohy needle, and for checking loss of resistance using radio-opaque contrast.

- Johnson T and Haslett R (2000). X-ray image intensifier assisted placement of a thoracic epidural. *Anaesthesia*, 55, 822–823. [letter]

- Johnson TW, Morgan R and Smalley P (2003). Radiographic guided epidural placement. *Anaesthesia*; 58, 485–486. [letter]

### 2.2.6 Fibreoptic guided placement

- Chien-Kun Ting *et al.* (2010). A new technique to assist epidural needle placement: fiberoptic-guided insertion using two wavelengths. *Anesthesiology*; 112, 1128–1135. [successful pilot in pigs]

## 2.3 Drugs

A fairly typical intraoperative epidural dose for a thoracotomy in an adult would be approximately 100–200 μg fentanyl plus 15–20 mls 0·25 % bupivicaine during the course of the operation. One approach is to mix 200 μg fentanyl plus 6 mls 0·25% bupivicaine into the first 10 ml syringe, and give this initial dose over about 15–30 mins depending on the blood pressure. In elderly patients consider reducing the dose of fentanyl.

The usual postoperative regimen at the City Hospital is to use a standardised pre-filled bag (500 mls) containing a mixture of fentanyl 2 mg + bupivicaine 0·125%, starting at about 5 mls/hr (range 0–10 mls/hr). These bags are kept in the recovery room in the DDA cupboard. Typically this standard regimen is started at the begining of the operation and adjusted accordingly.

An alternative system, suitable for either ITU or HDU, is to use a syringe-driver—in this case a typical regimen for an adult would be to mix 200 µg fentanyl plus 56 mls of 0·25% bupivicaine (total 60 mls), starting at about 5 mls/hr (range 0–10 mls/hr).

The ideal mixture of fentanyl and bupivicaine is somewhat controversial, and practice varies widely. The optimum concentration for epidural fentanyl was stated to be 10 µg/ml fentanyl by Welchew EA (1983), who also noted that the addition of 0·125% bupivicaine can improve the analgesia. A greater strength of bupivicaine is said not to significantly improve analgesia, while a lower concentration of bupivicaine appears to have no advantage over using fentanyl alone (Badner *et al.* 1994).

A recent study by Tan *et al.* (2004) compared fentanyl concentrations of 2, 5, and 10 µg/ml in bupivicaine 0·1% (plain) for thoracic epidurals, found that a concentration of fentanyl 5 µg/ml gave the optimum balance between excessive pain and excessive sedation.

Clonidine was used in thoracic epidurals for laparotomy by Curatolo *et al.* (2000); they suggested that an optimum combination was clonidine (5 µg/hr) plus bupivicaine (9 mg/hr) plus fentanyl (21 µg/hr). The addition of adrenaline to bupivicaine and fentanyl reduced plasma fentanyl concentrations.

**Postoperative pain-relief algorithm**: There is a comprehensive algorithm printed on a poster in the thoracic high-dependency ward. Copies can be obtained from the thoracic surgeons.


- Badner NH, Bhandari R, Komar WE (1994). Bupivicaine 0·125% improves continuous postoperative epidural fentanyl analgesia after abdominal or thoracic surgery. *Can. J. Anaesth.*; 41, 387–392.

- Casati A, Alessandrini P, Nuzzi M, Litti E *et al.* (2006). A prospective, randomised, blinded comparison between continuous thoracic paravertebral and epidural infusion of 0·2% ropivacaine after lung resection surgery. *European Journal of Anaesthesiology*; 23, 999–1004. [paravertebral is just as effective as epidural for analgesia, and has fewer haemodynamic complications]

- Curatolo M, Schnider TW, Petersen-Felix S, Weiss S, Signer C, Scaramozzino P and Zbinden AM (2000). A direct search procedure to optimize combinations of epidural bupivicaine, fentanyl and clonidine for postoperative analgesia. *Anesthesiology*; 92, 325–337. [thoracic epidurals]

- Tan CNH, Guha A, Scawn NDA, Pennefather SH and Russell GN (2004). Optimal concentration of epidural fentanyl in bupivicaine 0·1% after thoracotomy. *Br. J. Anaesth.*; 92, 670–674. [fentanyl 5 µg/ml was optimum]

- Welchew EA (1983). The optimum concentration for epidural fentanyl. A randomised double-blind comparison with and without 1:200,000 adrenaline. *Anaesthesia*; 38, 1037–1041.

# 2.4 Complications

## 2.4.1 Epidural catheter disconnection

The problem of how to proceed if the epidural catheter itself becomes disconnected from the filter is addressed by Grewal, Hocking and Wildsmith (2006), as follows.

> A common concern is what to do if the epidural infusion system becomes disconnected somewhere between the bacterial filter and the patient. An interesting laboratory study using deliberately contaminated catheters suggested that reconnection is safe within 8 hrs provided that the fluid inside the catheter is static (or the meniscus has moved $< 12{\cdot}5$ cm) and does not move when lifted above the level of the patient. The outside must be soaked in 10 % povidone iodine solution, or similar, for 3 mins and allowed to dry thoroughly before up to 20 cm is cut from the end with a sterile instrument. If these conditions are not met, the catheter must be removed.
>
> Grewal, Hocking and Wildsmith (2006)

- Grewal S, Hocking G and Wildsmith JAW (2006). Epidural abscesses. [review article] *Br. J. Anaesth.*; 96, 292–302.

## 2.4.2 Abscess

Literature reports of epidural abscess suggest that this complication is not uncommon (about 0·1%). Patients should be examined frequently for fever, local tenderness and neurological deficit. The excellent review by Grewal, Hocking and Wildsmith (2006) and the AAGBI (2002) guidelines should be essential reading for all.

- AAGBI (2002). *Infection control in anaesthesia.* (Association of Anaesthetists of Great Britain and Ireland).
- Gosavi C, Bland D, Poddar R and Horst C (2004). Epidural abscess complicating insertion of epidural catheters. *Br. J. Anaesth.*; 92, 294.
- Grewal S, Hocking G and Wildsmith JAW (2006). Epidural abscesses. [review article] *Br. J. Anaesth.*; 96, 292–302. [see reply by Jeffreys Horton and Evans 2006]
- Jeffreys A, Horton R and Evans B (2006) Epidural abscesses. *Br. J. Anaesth.*; 97, 115–116.
- Ng KP (1996). Complete heart block during laparotomy under combined thoracic epidural and general anaesthesia. *Anaesthesia and Intensive Care*; 24, 257–260.

- Roberts CJ (2004). Epidural abscess complicating insertion of epidural catheters. *Br. J. Anaesth.*; 92, 294–295.


### 2.4.3 Haematoma & DVT prophylaxis

Low molecular weight heparin (LMWH, enoxaparin, tinzaparin) is currently used in thoracic surgery. It is given once daily in the evening in order to facilitate day-time epidurals. Peak plasma concentrations occur at 4 hours and activity persists up to 24 hours. The PT and APTT are not generally affected by therapeutic doses, so monitoring requires measurement of anti-factor Xa levels (Roberts *et al.* 2004; Hirsh *et al.* 2001).

Epidural catheters should not be removed earlier than 8 hours following anticoagulation. See Mcleod and Cumming (2004) for an overview. European guidelines recommend (a) once daily dosing with LMWH, (b) 12 hr interval between injection and either epidural catheter insertion or removal (Wheatley *et al.* 2001).


- McLeod GA and Cumming C (2004). Thoracic epidural anaesthesia and analgesia. *Continuing Education in Anaesthesia, Critical Care and Pain*; 4 (No. 1), 16–19. [BJA]

- Hirsh J, Warkentin TE, Shaughnessy SG, Anand SS, Halperin Jl, Raschke R, Granger C, Ohman EM and Dalen JE (2001). Heparin and low-molecular-weight heparin: mechanisms of action, pharmacokinetics, dosing, monitoring, efficacy and safety. *Chest*; 119 (Suppl); 64S–94S.

- Horlocken TT and Heit JA (1997). Low molecular weight heparin: biochemistry, pharmacology, perioperative prophylaxis regimens and guidelines for regional anaesthetic management. *Anaesthesia and Analgesia*; 85, 874–885.

- Kearon C and Hirsh J (1997). Management of anticoagulation before and after elective surgery. *NEJM*; 336, 1506–1511.

- Roberts HR, Monroe DM and Escobar MA (2004). Current concepts of hemostasis: implications for therapy. *Anesthesiology*; 100, 722–730.


## 2.5 Paravertebral block

Naja, Ziade *et al.* (2004) suggest that the paravertebral space is divided into a potential anterior (extrapleural) and posterior (sub-endothoracic) compartments by a so-called endothoracic fascia, and that such spaces influence drug spread—see reply letters by Fitzgerald and Harmon (2004) and by Naja and Lönnqvist (2004) for more references and discussion.

As regards efficacy, it seems that a paravertebral block compares well with an epidural block (see Casati *et al.* 2006; Mathews and Govenden 1989).


- Casati A, Alessandrini P, Nuzzi M, Litti E *et al.* (2006). A prospective, randomised, blinded comparison between continuous thoracic paravertebral and epidural infusion of 0·2% ropivacaine after lung resection surgery. *European Journal of Anaesthesiology*; 23, 999–1004. [paravertebral is just as effective as epidural for analgesia, and has fewer haemodynamic complications]

- Conacher ID and Kokri M (1987). Postoperative paravertebral blocks for thoracic surgery. *Br. J. Anaesth.*; 59, 155–161.

- Eason MJ and Wyatt R (1979). Paravertebral thoracic block—a reappraisal. *Anaesthesia*; 34, 638–642.

- Fitzgerald K, Harmon D *et al.* (2004). Thoracic paravertebral blockage. *Anaesthesia*; 59, 1028–1029. [letter: reply to Naja *et al.* 2004]

- Govenden V and Mathews PJ (1988). Percutaneous placement of paravertebral catheters during thoracotomy. *Anaesthesia*; 43, 256.

- Loader J and Ford P (2009). Thoracic paravertebral block. *Update in Anaesthesia* (June 2009), p. 4–7. http://update.anaesthesiologists.org/2009/ [good practical overview]

- Karmakar MK (2001). Thoracic paravertebral block. *Anesthesiology*; 95, 771–780. [review]

- Mathews PJ and Govenden V (1989). Comparison of continuous paravertebral and extradural infusions of bupivicaine for pain relief after thoracotomy. *Br. J. Anaesth.*; 62, 204–205. [paravertebrals were associated with less hypotension and less urine retention; analgesia was the same in both groups]

- Naja MZ, Ziade MF, Rajab El *et al.* (2004). Varying anatomical injection points within the thoracic paravertebral space: effect on spread of solution and nerve blockade. *Anaesthesia*; 59, 459–463. [see interesting reply letter by Lang and Saito (2005): *Anaesthesia*; 60, 930–931]

- Naja MZ *et al.* (2005). Distance between the skin and the thoracic paravertebral space. *Anaesthesia*; 60, 680–684. [median depth was 55 mm; the depth was least in the T4–T8 zone]

- Naja MZ, Lönnqvist PA *et al.* (2004). Thoracic paravertebral blockage. *Anaesthesia*; 59, 1028–1029. [letter: reply to Fitzgerald *et al.* 2004]

- Richardson J, Cheema SPS, Hawkins J and Sabanathan S (1996). Thoracic paravertebral space location. *Anaesthesia*; 51, 137–139. [used pressure measurement during needle advancement; sudden pressure fall as needle traverses the superior costo-transverse ligament]