

High vs Mid Thoracic Epidural Analgesia – A Comparative Study on the Ease of Insertion and Effects on Pain, Hemodynamics, and Oxygenation in Patients Undergoing Thoracotomies

Abstract

Background: Thoracic epidural analgesia offers effective perioperative pain relief in patients undergoing thoracotomies apart from attenuating stress responses. It helps in fast tracking by facilitating early mobilization and improving respiratory function. Literature on high (T1–T2 level) thoracic segmental analgesia for thoracotomy is less. **Aim:** The aim of present study was to compare the ease of insertion, effect on pain relief in high (T1–T2 level) vs mid (T5–T6) approach of thoracic epidural. **Setting and Design:** The present study was a randomized control trial conducted at our institute. **Materials and Methods:** About 52 patients aged between 18–65 years scheduled for elective thoracotomies under general and thoracic epidural anesthesia were randomized into two groups. Intraoperatively ease of epidural insertion, extent of blockade, and postoperatively pain relief were assessed. Ropivacaine with fentanyl was used for epidural analgesia. **Statistical Analysis:** Data were presented as mean \pm standard deviation and analyzed by the Student's *t* test, Chi-square test, and non-parametric test wherever applicable. A *P* value <0.05 was considered statistically significant. **Results:** We observed that high thoracic epidural anesthesia was easier to place (time taken 123.42 vs 303.08 s) $P < 0.05$, with less number of attempts (1.27 vs 1.92) $P < 0.05$. Extent of blockade, postoperative pain scores, rescue analgesia requirement, hemodynamics, and oxygenation were comparable. **Conclusion:** We conclude that high thoracic epidural is easier to insert, provides adequate pain relief, and stable hemodynamics with the advantage of patient comfort and safety.

Keywords: Ease of technique, high thoracic epidural, pain relief, ropivacaine, thoracotomies

Introduction

Thoracic epidural anesthesia is used for perioperative pain relief in patients undergoing thoracic, upper abdominal, colorectal, and gynecological surgeries.^[1] It decreases the neurohumoral stress responses apart from providing better analgesia.^[2] In the postoperative period, it helps in fast tracking by facilitating early mobilization, improved cough reflex, better quality of recovery, and less intensive care unit stay.^[3] Thoracic epidural analgesia also reduces chronic post-thoracotomy pain.^[4,5] Inadequate pain relief will cause inadequate cough, pooling of secretions, increases risk of atelectasis, postoperative infections, and patients will be prone for prolonged morbidity.

Thoracic epidural analgesia using local anesthetic and opioid combination can cause hypotension. Placing the epidural catheter at the level of surgical incision

site is recommended to reduce the amount of local anesthetic and opioid requirement. However, identifying the epidural space at mid thoracic level (T5–T6) for posterolateral thoracotomies is difficult due to acute angulation of thoracic spines, this also increases the depth to epidural space from the skin.^[6] Owing to the same reason, failure rates are high at this level. In contrast, high thoracic epidural space (T1–T2) identification is easier due to less angulation of the vertebral spinous process. However, safety and adequacy of analgesia provided by this approach for posterolateral thoracotomies were not studied till date.

This randomized study was undertaken to compare high (T1–T2) vs mid (T5–T6) approach of placement of thoracic epidural in relation to ease of technique (by time taken to identify the epidural space and number of attempts) apart from identifying the extent of blockade,

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hemodynamics [mean arterial pressure (MAP), heart rate (HR)] and oxygenation (pO_2/FiO_2), serum lactate levels, postoperative pain assessed by the Visual Analogue Scale (VAS), and requirement for rescue analgesia. Use of ropivacaine for epidural analgesia causes less motor blockade with less side effects on cardiovascular and central nervous system compared to bupivacaine.^[7]

Materials and Methods

After obtaining approval from the institutional ethical committee and taking informed consent, 52 patients of age 18–65 years, the American Society of Anesthesiologists (ASA) Grade I and II scheduled for elective thoracotomies by mid posterolateral incision, at our institute were included. All patients were grouped into high and mid thoracic epidural groups by computer-generated randomized chart. In high approach, epidural catheter was placed in T1–T2 level and T5–T6 in mid approach. Duration of the study was 9 months from March to December 2016.

The exclusion criteria included patients with known drug allergy to local anesthetics or opioids, coronary artery disease, chronic kidney disease, chronic liver disease, cerebrovascular accident, redo surgeries, spine deformities, patients found to be at risk for need of elective ventilation during preanesthetic checkup (PAC), poor left ventricular function (ejection fraction <50%), and right ventricular systolic pressures >45 mmHg. Exclusion after inclusion criteria included patients found to be at need for postoperative ventilator support intraoperatively.

During PAC, on the evening prior to surgery all the patients were explained about the anesthesia procedure and educated about the VAS and measurement of pain from 0–10 on the scale.

The anesthetic technique was as per standard protocols and all the epidurals were placed by a single experienced operator, premedication was given on the night before and morning of surgery in the form of tablet pantoprazole 40 mg and tablet alprazolam 0.50 mg per oral.

After checking the anesthesia machine, keeping all emergency drugs ready, patient was shifted inside the operating room, monitors attached, intravenous (IV) line secured, and antibiotic administered. Base line SpO_2 on room air was noted and oxygen supplemented with face mask at 4 l per min.

Arterial line was secured under local anesthetic (LA) infiltration, with aseptic conditions under LA epidural space was identified (T1–T2 in high approach, T5–T6 in mid approach) in sitting position using 18G Tuohy needle (epidural mini pack system, Smiths Medical India Pvt Limited) by loss of resistance to air technique. In high group, Tuohy needle hub was directed caudally (in mid group cephalad), 18G portex epidural clear catheter with

three lateral eyes was passed, inserted 5 cm beyond the needle tip, needle removed.

After checking the patency of the catheter, catheter was fixed with a fixator (Smiths Medical India Pvt Limited), 2 ml of 0.25% ropivacaine was given and patient placed in the supine position then another 3 ml of 0.25% ropivacaine was given. Sensory blockade was checked after 5 min of second aliquot. Sensory blockade was checked by sensation to cold using a cold alcohol swab bilaterally, lateral to mid clavicular line and scoring was given as follows; 0 if no change in sensation, 1 for decreased perception, and 2 for loss of cold sensation.

Sensory block was taken as achieved if score was 2. Additional 3 ml of drug was given. Under aseptic conditions and LA central line was secured. Entropy was connected before induction of anesthesia. After preoxygenation with 100% O_2 for 3 min patient was induced with standard doses of IV fentanyl 2 μ g/kg, midazolam 0.02 mg/kg, thiopentone till loss of eye lash reflex, sevoflurane 2% was started. Neuromuscular transmission (NMT) monitor was connected and reference value was taken after induction and before giving relaxant. After checking for ability to ventilate, IV rocuronium 1 mg/kg was given, intubation was done once Train of Four (TOF) was zero, with double lumen tube size of 32–35 Fr if female and 35–37 Fr if male. Position of the tube, air entry was checked by auscultation, tube was fixed and connected to intermittent positive pressure ventilation.

Anesthesia was maintained with volume control ventilation with tidal volume 6–7 ml/kg, FiO_2 titrated to achieve saturation of >94%. IV fentanyl 0.008 μ g/kg/min was started. Atracurium infusion was titrated to TOF count of 1–2 twitches and entropy was maintained at 50–60 with sevoflurane. Epidural infusion 0.25% ropivacaine with fentanyl 2 μ g/ml was started at a rate adjusted to patient's height, 5 ml/h up to 160 cm, 0.5 ml increment for every 5 cm >160 cm. Intraoperatively parameters like HR, electrocardiogram (ECG), end-tidal carbon dioxide concentration ($ETCO_2$), MAP, NMT, central venous pressure (CVP), entropy, urine output, temperature were monitored. Arterial blood gas (ABG) analysis sampling was done before induction, 10 min after intubation, 20 min after initiation of one lung ventilation, and 20 min post two lung ventilation. Any episode of hypotension (decrease in MAP by 30%) was treated with 50 ml of IV ringer lactate bolus, if there was no response IV phenylephrine 50 μ g repeated up to three times followed by inotrope infusion (dopamine 5–10 μ g/kg/min). Hypertension (increase in MAP by 30%) was treated with 5 ml bolus of 0.25% ropivacaine repeated twice 10 min apart and then by incremental doses of IV propofol 20 mg. All patients received ondansetron and paracetamol 1 g intravenously prior to extubation. All the patients were reversed with glycopyrrolate 0.02 mg/kg and neostigmine 0.05 mg/kg at the end of procedure and extubated after complete recovery. Patients found to

be in need for mechanical ventilation intraoperatively were labeled under exclusion after inclusion criteria and excluded from the study. All patients were shifted to intensive care unit for postoperative care and received oxygen supplementation at 6 l/min. Epidural infusion of 0.125% ropivacaine and 2 µg/ml fentanyl was continued till 48 h after surgery. Pain assessment was done by the VAS score and hemodynamic parameters (MAP, HR) were noted at 30 min, 1, 6, 12, 24, and 48 h postoperatively. ABG analysis was done at 0 h, 6 h, and on the morning of first postoperative day.

IV tramadol 50 mg was given as rescue analgesia if the VAS >3 or on patient's demand. Second line of rescue analgesia was 1 g of IV paracetamol followed by ketoprofen patch. Complications like nausea, vomiting, paresis, hypotension, respiratory depression, and pruritus were noted.

Statistics

All the data were presented as mean ± standard deviation. All data were analyzed by the Student's *t* test (independent samples *t* test), Chi-square test, and Fischer's exact test wherever applicable. Non-parametric tests were used whenever mean value was less than two times standard deviation. *P* value <0.05 was considered statistically significant. SPSS 17.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis.

Results

Both the groups were comparable with regards to demographic data, type, and duration of surgery [Table 1]. Time taken from Tuohy needle insertion to epidural space identification (123.42 s vs 303.08 s, *P* < 0.05) and number of attempts was significantly less (1.27 vs 1.92, *P* < 0.05) [Table 2].

Time of onset of analgesia (10.54 vs 10.13 min) and number of segments blocked (5.96 vs 5.79) was comparable in both the groups [Table 2]. Significantly less number of patients in high group (18 vs 24) achieved level of T6 with bolus of 5 ml of 0.25% ropivacaine (*P* < 0.05) [Table 2]. HR, MAP, pO₂/FiO₂ ratio, serum lactate levels were comparable in both the groups [Tables 3–5]. Amount of ropivacaine consumed in both the groups was comparable (4.72 ml vs 5.06 ml, *P* > 0.05) [Table 1]. VAS score assessed at 30 min, 1, 6, 12, 24, and 48 h was comparable in both the groups (*P* > 0.05) [Table 5].

None of the patients developed postoperative lung infections, respiratory depression, pruritus, and hemodynamically significant arrhythmias. No mortality was observed in the study cases. Five patients (three from high group and two from mid thoracic group) developed hypotension out of which two patients, one from each required dopamine support. Epidural catheter was accidentally removed during positioning in two patients from high thoracic group and one from mid thoracic

Table 1: Demographic data, surgical information, and local anesthetic consumption

Parameter	High (n=26)	Mid (n=24)	<i>P</i>
Age (years)	39.46±16.17	37.54±12.3	0.61
Sex (female:male)	10:16	9:15	0.94
Height (cm)	158.85±7.8	159.21±8.1	0.873
Weight (kg)	48.65±9.8	53.42±13.2	0.152
Type of surgery (L:P:D:O)*	12:3:9:2	15:0:5:4	0.167
Duration of surgery (h)	3.51±1.06	3.635±1.3	0.72
LA [†] consumed (ml)	4.72±1.6	5.060±1.9	0.510

*L=Lobectomy; P=Pneumonectomy; D=Decortication; O=Others;

†LA: Intraoperative local anesthetic (ropivacaine)

Table 2: Ease of insertion and extent of blockade

	High (n=26)	Mid (n=24)	<i>P</i>
Time taken to identify epidural space(s)	123.42±123.48	303±299.1	0.007
Number of attempts	1.27±0.45	1.92±1.28	0.019
Time of onset of blockade (min)	10.54±4.6	10.13±4.81	0.758
Number of segments blocked	5.96±1.3	5.79±0.93	0.614
T6 level achieved	18	24	0.003

Table 3: Intraoperative hemodynamics

Variable	High (n=26)	Mid (n=24)	<i>P</i>
Heart rate (HR*)			
HR B [‡]	104.31±26.56	98.75±19.91	0.41
HR Ep [§]	106.62±25.5	101.63±17.17	0.42
HR 5 min	103.23±24.14	99±18.58	0.49
HR 10 min	98.77±19.52	99.71±17.42	0.85
HR 20 min	95.08±16.73	88.92±15.50	0.18
HR 30 min	91.08±16.38	86.83±14.56	0.33
HR 1 h	90.50±17.37	85.54±15.67	0.29
HR 2 h	84.81±17.55	80.13±14.46	0.31
HR 3 h	81.04±17.32	77.79±16.18	0.49
Mean arterial pressure (MAP [†])			
MAP B	98.46±11.93	101.50±10.58	0.34
MAP Ep	99.50±15.56	100.54±11.50	0.79
MAP 5 min	95.65±15.95	98.54±12.89	0.48
MAP 10 min	95.92±13.10	95.88±13.68	0.99
MAP 20 min	94.35±18.50	89.88±18.16	0.39
MAP 30 min	85.38±16.64	84.38±16.77	0.83
MAP 1 h	87.65±13.58	82.46±11.59	0.15
MAP 2 h	83.50±15.46	80.21±10.67	0.38
MAP 3 h	80.77±10.63	82.67±9.39	0.50

*HR=Heart rate, †MAP=Mean arterial pressure, ‡B=Baseline,

§Ep=Epidural, ||h=Hours

group. For these patients, VAS score was not included for final statistical analysis. Two patients from high thoracic group developed weakness of upper limb on the same side of surgery. Two patients from mid thoracic group were decided to be put on elective ventilation due to massive bleeding and prolonged surgery and thus excluded from statistical analysis. Only one patient from high thoracic

group developed nausea. None of the patients developed respiratory depression (respiratory rate <9 per minute) and pruritus. All patients were successfully transferred out of intensive care unit at the end of 48 h after epidural catheter removal. Figure 1 shows consort diagram of patients enrolled for study.

Table 4: Intraoperative and postoperative oxygenation

Variable	High (n=26)	Mid (n=24)	P
Intraoperative pO ₂ /FiO ₂			
pO ₂ /FiO ₂ B	563.02±168.67	593.06±233.6	0.60
pO ₂ /FiO ₂ int	397±94.74	361.67±101.88	0.21
pO ₂ /FiO ₂ olv	320.25±108.9	284.9±109.6	0.26
pO ₂ /FiO ₂ tlv	336.22±80.4	347.75±117.71	0.68
Intraoperative serum lactate levels			
Lactate B*	1.66±1.21	1.32±0.52	0.21
Lactate int†	1.43±0.47	1.45±0.6	0.94
Lactate olv‡	1.63±0.62	1.54±0.7	0.66
Lactate tlv§	1.85±8.1	1.91±1.03	0.80
Postoperative pO ₂ /FiO ₂			
pO ₂ /FiO ₂ 0	404±132.88	439.91±140.64	0.36
pO ₂ /FiO ₂ 6	432.35±120.85	453.81±156.89	0.58
pO ₂ /FiO ₂ 12	421.73±101.21	421.39±129.23	0.99
postoperative serum lactate levels			
Lactate 0	25.73±669	25.25±606	0.90
Lactate 6	24.75±643.50	26.31±631.50	0.70
Lactate 12	28.88±751	21.83±524	0.087

*B=Baseline, †int=Intubation, ‡olv=One lung ventilation, §tlv=Two lung ventilation

Table 5: Postoperative hemodynamics and visual analogue score (VAS)

Variable	High (n=26)	Mid (n=24)	P
Heart rate (HR)			
HR 30 min	86.85±19.8	89.33±20.9	0.66
HR 1 h	87±20.9	87.42±21.5	0.94
HR 6 h	93.73±23.2	92.13±24.3	0.81
Hr 12 h	93.73±21.72	94.92±24.4	0.85
HR 24 h	98.12±14.80	96.63±21.4	0.77
HR 48 h	96.15±13.9	90.58±16.3	0.20
Mean arterial pressure (MAP)			
MAP 30 min	85.88±15.5	85.96±9.0	0.98
MAP 1 h	79.54±13.1	82.63±9.1	0.34
MAP 6 h	83.31±15.15	80.29±13.6	0.46
MAP 12 h	80.00±10.42	80.83±10.6	0.78
MAP 24 h	84.00±8.87	86.83±5.42	0.18
MAP 48 h	81.38±5.91	81.75±6.48	0.83
VAS			
VAs 30 min	3±1.64	3.42±1.69	0.38
VAs 1 h	2.5±1.20	2.92±1.50	0.28
VAS 6 h	2.46±1.06	2.50±1.10	0.90
VAs 12 h	2.50±1.27	2.71±1.08	0.53
VAS 24 h	2.42±0.92	2.52±1.03	0.71
VAS 48 h	2.35±0.88	2.61±0.83	0.31

Discussion

Patients undergoing thoracotomy experience severe pain due to various reasons like skin incision, separation of the thoracic muscles, rib retraction or resection, thoracotomy wound retraction, lateral decubitus position, handling of intercostal nerves, and intercostal drain insertion. Source of noxious stimuli is from the skin, intercostal muscles, parietal pleura. Inadequate pain relief will decrease patient's compliance with chest physiotherapy, incentive spirometry, and cough. Advantages of pain relief are patient comfort, better coughing, clearance of secretions, no atelectasis, and less chance of respiratory failure.^[8,9] Thoracic epidural analgesia has an advantage over other analgesic techniques as it was confined to the dermatomal distribution of skin incision thus avoiding side effects of parenteral opioid like respiratory depression and ineffective cough and analgesia can be graded to maintain stable hemodynamics. Segmental analgesia causes minimal motor blockade, helps in better cough reflex, and respiratory function.^[10,11]

Ropivacaine provides better sensory analgesia with less motor blockade and side effects compared to bupivacaine.^[7] Opioid plus local anesthetic combination for epidural infusion has synergistic effect. Thoracic epidural analgesia helps in early patient mobilization due to pain relief thus incidence of deep vein thrombosis is less.

The safety of high thoracic epidural anesthesia was studied in awake cardiac surgeries.^[12,13] Our study support the fact that due to more acute angulation of thoracic vertebra in the mid thoracic spine, mid thoracic epidural was difficult to insert compared to high approach and also that high thoracic epidural was easier to insert, provides segmental analgesia both of which have better patient comfort and satisfaction.

Extent of blockade was similar to the mid thoracic group even though the level of insertion was relatively far from surgical incision site probably due to the caudal direction of the Tuohy needle hub which likely facilitates advancement of catheter caudally.^[14]

Complications included epidural catheter displacement in three patients (two from high group and one from mid group) during positioning for chest X-ray on the morning of the first postoperative day. We recommend prior counseling of nursing staff regarding proper inspection of epidural catheter dressing. Two patients from mid thoracic group were decided to be put on elective ventilation due to prolonged duration of surgery and bleeding intraoperatively during release of adhesions. Two patients one from each group required dopamine support to maintain MAP. Only one patient in high group developed nausea on the first postoperative day and was treated with ondansetron intravenously.

Two patients from high thoracic group developed upper limb weakness which was relieved after withdrawing the epidural catheter by 2 cm.

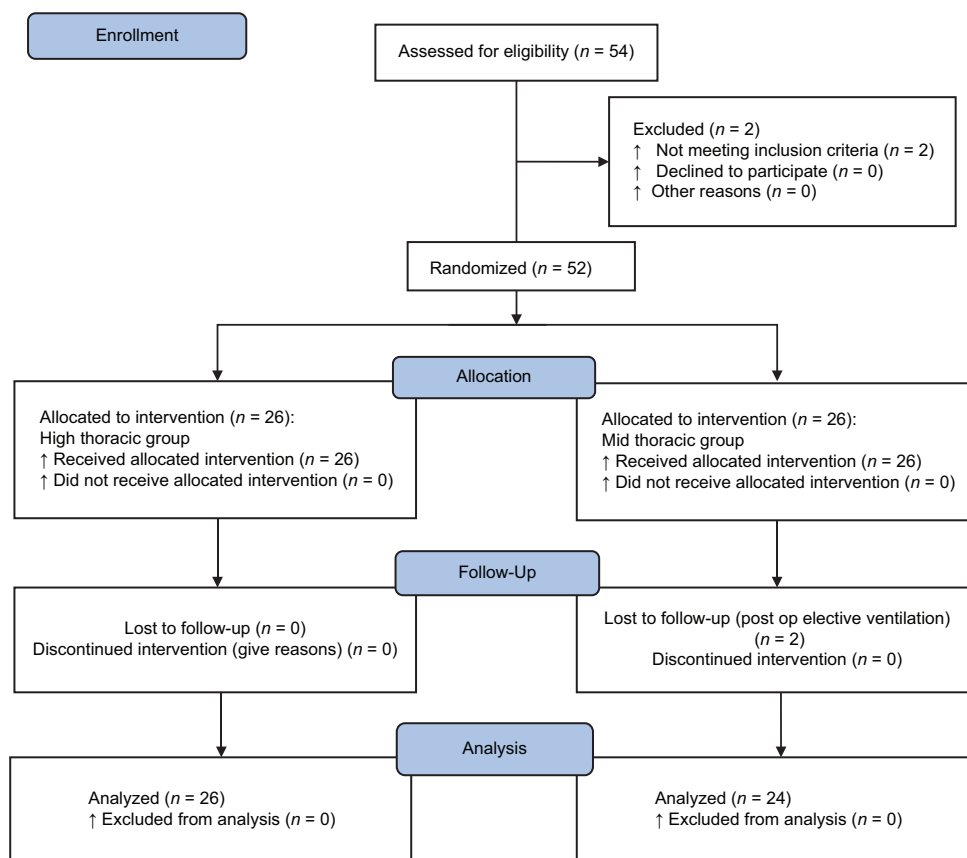


Figure 1: Consort diagram

Limitations of the study were exact location of catheter tip could not be ascertained. Exact reason for not achieving analgesia up to T6 in eight patients under high thoracic group could most probably be due to insufficient bolus dose (5 ml).

Conclusion

After comparing the statistics while performing the procedure and postoperatively we conclude that high thoracic epidural anesthesia was easier to insert compared to mid approach; advantage being patient comfort and safety and provides adequate pain relief and stable hemodynamics similar to mid thoracic epidural anesthesia.

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Conflicts of interest

There are no conflicts of interest.

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