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Original Research Article

Analgesic Efficacy and safety of Thoracic Epidural versus Paravertebral Blockade for Post-Thoracotomy Pain Relief

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Abstract:

Background: Effective management of post-thoracotomy pain is crucial for patient recovery. This study compared the analgesic efficacy and safety profiles of Thoracic Epidural Block (TEB) and Paravertebral Block (PVB) in this context.

Methods: A total of 100 patients undergoing thoracotomy were randomly assigned to receive either TEB or PVB. Pain was assessed using the Visual Analogue Scale (VAS) at various postoperative intervals. Hemodynamic parameters (heart rate and mean arterial pressure) and lung function (FEV1, FVC and PEFR) were also measured. The incidence of side effects was recorded.

Results: No significant difference was observed in VAS scores for pain at rest and during coughing between TEB and PVB groups ($p>0.05$). Hemodynamic analysis revealed significant variations in the TEB group at certain postoperative intervals, with a notable decrease in mean arterial pressure at 15, 30 and 60 minutes ($p<0.05$). Lung function parameters (FEV1, FVC and PEFR) postoperatively showed no significant difference between the groups. The incidence of nausea, vomiting, and urinary retention was higher in the TEB group.

Conclusion: Both TEB and PVB are effective for post-thoracotomy pain management. However, TEB is associated with more pronounced hemodynamic variations and a higher incidence of certain side effects. These findings can guide clinicians in tailoring postoperative pain management strategies to individual patient needs.

Keywords: Thoracic Epidural Block, Paravertebral Block, Post-thoracotomy Pain, Hemodynamic Stability, Lung Function.

Introduction

Thoracotomy, a major surgical intervention involving an incision into the pleural space of the chest, is associated with significant postoperative pain. Managing this pain is crucial, as inadequate control can lead to complications such as pneumonia, atelectasis and chronic post-thoracotomy pain syndrome (CPTPS) [1]. In recent years, thoracic epidural analgesia (TEA) and paravertebral blockade (PVB) have emerged as prominent methods for managing post-thoracotomy pain, yet their relative efficacy and safety continue to be a subject of ongoing research and debate in the medical community [2,3].

TEA has long been considered the gold standard for post-thoracotomy pain management. Its effectiveness in pain control and reducing pulmonary complications has been well-documented [4]. However, the technique is not without risks; complications such as hypotension, urinary retention and potential for severe neurological injury, albeit rare, are concerns [5]. Furthermore, the technical demands and contraindications of epidural placement, such as patient coagulopathy or use of anticoagulants, limit its universal application [6].

On the other hand, PVB, a relatively newer technique, has gained popularity as an alternative to TEA. PVB provides unilateral segmental anesthesia and is purported to have a lower risk profile, particularly with respect to hypotension and motor blockade [7]. Studies have indicated that PVB is as effective as TEA in controlling pain, with some suggesting even superior pain control in the immediate postoperative period [8]. Moreover, PVB's potentially lower incidence of complications and its feasibility in patients with contraindications to epidural analgesia make it an attractive option [9].

The debate between TEA and PVB is not solely about efficacy in pain control but also encompasses safety profiles, patient satisfaction, and impact on postoperative recovery and complications. The comparative risk of chronic pain, such as CPTPS, and the influence of each technique on cancer recurrence rates due to differences in local anesthetic exposure and systemic opioid sparing, are currently under investigation [10, 11]. Additionally, the choice between these techniques can be influenced by surgeon and anesthesiologist preference, institutional protocols and patient-specific factors [12].

Given the evolving nature of pain management in thoracic surgery, this article aims to comprehensively review the latest evidence comparing the analgesic efficacy and safety of TEA and PVB in post-thoracotomy pain management. This study will delve into the mechanisms of action, efficacy in acute pain control, impact on chronic pain development, safety profiles, patient satisfaction and overall outcomes associated with these two techniques. This comparison is crucial for informing clinical practice and guiding future research in the quest to optimize post-thoracotomy pain management.

Aim and Objectives of the Study

The study, conducted at the Cardiothoracic and Vascular Surgery Operation Theatre of the Department of Anesthesiology at Assam Medical College and Hospital, Dibrugarh, was aimed at evaluating the relative effects of Thoracic Epidural Block (TEB) and Paravertebral Block (PVB) on post-thoracotomy pain relief, along with assessing other risk factors associated with these interventions.

The specific objectives were to compare TEB and PVB in adults undergoing elective thoracotomy with respect to their analgesic efficacy in relation to post-operative pain relief during the initial 6 hours, their effects on hemodynamics during the observed period, and their impact on pulmonary/lung function.

Materials and Methods

This hospital-based observational study was carried out over one year and involved a sample size of 100 patients, divided equally into two groups of 50 each. This sample size was determined based on a 95% confidence interval with a margin of error of 20%, referencing the study by Jonathan Wong et al. [13].

Inclusion criteria encompassed all patients aged between 18 and 75 years with an ASA Physical status of I, II or III, who were scheduled for lung surgery via open thoracotomy. Patients who did not give consent, those requiring additional chest wall resection, undergoing emergency surgery, pregnant or with contraindications to regional techniques (such as allergy to local anaesthetics or coagulation disorders), were excluded.

Ethical clearance for the study was duly obtained from the Institutional Ethics Committee (H) of Assam Medical College and Hospital, and written informed consent was secured from all participants.

Patients were randomly allocated into two groups: Group PVB received a paravertebral block and Group TEB received a thoracic epidural block with a single bolus dose of 15 ml of 0.2% Ropivacaine injection. Pre-operative preparation included a detailed pre-anaesthetic evaluation, thorough clinical examination and appropriate laboratory investigations based on the patients' clinical profiles and the proposed surgery.

The anesthesia technique involved premedication with Tab. Alprazolam and standard pre-operative procedures including intravenous access, attachment of standard monitors, preloading with crystalloid solution, and administration of Inj. Glycopyrrolate and Inj. Ondansetron. The specifics of administering PVB and TEB, including catheter placement, were meticulously followed as per established protocols before administering the General Anesthesia. A 20G epidural catheter was placed into the thoracic paravertebral space (T4-8 paravertebral space) in Group PVB and in thoracic epidural space at T4/5, T5/6 or T6/7 interspaces (depending on the site of surgery) in Group TEB. General anaesthesia was induced using injection Fentanyl, Propofol and Atracurium, with maintenance using Oxygen, Nitrous oxide and Sevoflurane. Then, the study drug was administered towards the end of the surgery just before extubation.

Postoperative pain management included instructing patients on using the visual analogue scale (VAS) for pain assessment. Non-pain related postoperative management included monitoring non-invasive blood pressure, SpO_2 and heart rate hourly, with specific interventions for hypotension and bradycardia.

The primary outcome measures were pain intensities at rest and during coughing/movement assessed by VAS score, and secondary outcome measures included hemodynamic parameters and pulmonary/lung function like Forced Expiratory Volume in 01 Second (FEV1), Forced Vital Capacity (FVC) and Peak Expiratory Flow Rate (PEFR).

Equipment and drugs necessary for the procedures and resuscitation were thoroughly prepared and checked before the arrival of each patient.

Statistical analysis was carried out using SPSS for Windows version 16.0 and Microsoft Excel 2010. Descriptive statistics were calculated for

continuous variables, with Student's t-test used for comparing patient characteristics data and Fisher's exact test for categorical data. A probability value under 0.05 was considered statistically significant.

Results

In this investigation conducted at Assam Medical College and Hospital, Dibrugarh, the analgesic efficacy and hemodynamic effects of Thoracic Epidural Block (TEB) and Paravertebral Block (PVB) in post-thoracotomy pain management were meticulously evaluated. The study encapsulated a detailed analysis of various parameters including demographic characteristics, postoperative heart rate, mean arterial pressure, pain assessment through the Visual Analogue Scale (VAS), lung function tests and the incidence of side effects. The results, drawn from a well-structured and comprehensive dataset, are as follows:

Demographic and Preoperative Data: The demographic and preoperative data presented in Table 1 showed no significant differences between the two groups in terms of age (p=0.4633), height (p=0.3488) and weight (p=0.6961). The sex distribution was evenly matched in both groups with 60% male and 40% female participants, resulting in a non-significant p-value of 0.8415. Regarding ASA Physical Status, the distribution was also comparable between the two groups (p=0.7719). The types of surgeries undertaken were segment resection, lobectomy and decortication, with no significant difference in the distribution of these procedures between the groups (p=0.7225). Preoperative lung function, indicated by FEV1, FVC and PEFR values, was similar in both groups with p-values of 0.1277, 0.6276 and 0.7100, respectively.

Heart Rate: According to Table 2, the postoperative heart rate at various time points demonstrated significant differences at 15 minutes (p=0.0289), 30 minutes (p=0.0018) and 60 minutes (p=0.0088) postoperatively, favouring the PVB group with higher heart rates. However, at other time points including the baseline, 2, 3, 4, 5 and 6 hours postoperatively, the differences were not statistically significant.

Mean Arterial Pressure (MAP)

The comparison of postoperative mean arterial pressure, as shown in Table 3, revealed significant differences at 15 minutes (p=0.0040), 30 minutes (p=0.0001) and 60 minutes (p=0.0136) postoperatively. These findings indicated a trend towards lower MAP in the TEB group during these time intervals. However, at baseline, 2, 3, 4, 5 and 6 hours, no significant differences were observed.

Pain Assessment Using VAS: The Visual Analogue Scores for pain at rest and during coughing/movement are detailed in Tables 4 and 5. The VAS scores for pain at rest and during coughing/movement showed no significant differences between the two groups at all the time points (60 minutes, 2, 3, 4, 5 and 6 hours postoperatively), indicating similar pain control efficacy in both TEB and PVB.

Lung Function Postoperatively: Tables 6 and 7 presented the lung function parameters postoperatively. FEV1 and FVC values recorded at various time points up to 6 hours postoperatively were comparable between the two groups, with no statistically significant differences.

Peak Expiratory Flow Rate: The postoperative peak expiratory flow rate (PEFR), as depicted in Table 8, was also similar between the groups across all time points, indicating no significant impact of the analgesic technique on this aspect of lung function.

Side Effects: Table 9 summarizes the side effects observed in both groups. Notably, nausea and vomiting were infrequently reported, with slightly higher instances in the TEB group. Urinary retention was more pronounced in the TEB group, with 8 cases reported compared to none in the PVB group.

In summary, the study revealed that both Thoracic Epidural Block and Paravertebral Block are effective in managing post-thoracotomy pain, with no significant difference in pain scores. However, differences in heart rate and mean arterial pressure at certain postoperative intervals, and a higher incidence of urinary retention in the TEB group, highlight the nuanced variations between these two analgesic techniques.

Table 1: Combined Demographic and Preoperative Data

Characteristic	Group PVB	Group TEB	
Demographic Data	**Mean ± SD**	**Mean ± SD**	**p-value**
Age (years)	43.06 ± 14.08	41.10 ± 11.88	0.4633
Height (cm)	158.12 ± 5.75	159.11 ± 5.57	0.3488
Weight (Kg)	59.14 ± 6.63	59.54 ± 5.83	0.6961
Sex Distribution			
Male	30 (60%)	30 (60%)	0.8415
Female	20 (40%)	20 (40%)	

Total	50 (100%)	50 (100%)	
ASA Physical Status			
ASA–I	0 (0%)	0 (0%)	0.7719
ASA–II	28 (56%)	26 (52%)	
ASA–III	22 (44%)	24 (48%)	
Total	50 (100%)	50 (100%)	
Types of Surgery			
Segment Resection	6 (12%)	5 (10%)	0.7225
Lobectomy	18 (36%)	15 (30%)	
Decortication	26 (52%)	30 (60%)	
Total	50 (100%)	50 (100%)	
Preoperative Lung Function			
FEV1 (L)	2.44 ± 0.26	2.37 ± 0.17	0.1277
FVC (L)	2.77 ± 0.26	2.74 ± 0.19	0.6276
PEFR (L/sec)	5.44 ± 0.42	5.41 ± 0.58	0.7100

Table 2: Comparison of Heart Rate (Postoperative)

Time Point	Group PVB HR (Mean ± SD)	Group TEB HR (Mean ± SD)	p-value
Baseline	83.88 ± 7.36	83.38 ± 7.48	0.8256
5 min	81.98 ± 7.48	80.34 ± 7.36	0.3141
15 min	79.32 ± 7.14 *	75.88 ± 7.39 *	0.0289
30 min	78.04 ± 7.48 *	73.14 ± 7.09 *	0.0018
60 min	76.66 ± 7.22 *	72.64 ± 6.95 *	0.0088
2 hour	76.52 ± 6.75	75.72 ± 6.95	0.6716
3 hour	75.86 ± 6.42	75.70 ± 8.10	0.9764
4 hour	76.34 ± 5.99	75.14 ± 7.98	0.4350
5 hour	76.18 ± 6.01	76.04 ± 7.70	0.9671
6 hour	76.04 ± 5.95	77.92 ± 7.66	0.1642
*Significant (p-value<0.05)			

Table 3: Comparison of Mean Arterial Pressure (Postoperative)

Time Point	Group PVB MAP (Mean ± SD)	Group TEB MAP (Mean ± SD)	p-value
Baseline	91.79 ± 6.67	90.3 ± 7.54	0.3388
5 min	89.12 ± 6.02	87.51 ± 7.33	0.2694
15 min	88.29 ± 5.38 *	84.51 ± 6.87 *	0.0040
30 min	86.35 ± 4.75 *	81.75 ± 6.38 *	0.0001
60 min	85.29 ± 4.11 *	82.84 ± 4.99 *	0.0136
2 hour	85.88 ± 3.90	85.65 ± 4.06	0.8824
3 hour	86.85 ± 3.70	85.75 ± 4.14	0.2329
4 hour	86.85 ± 4.11	85.89 ± 4.42	0.3276
5 hour	86.57 ± 3.86	87.82 ± 4.13	0.0928
6 hour	86.23 ± 3.87	88.29 ± 3.84	0.0690
*Significant (p-value<0.05)			

Table 4: Visual Analogue Score (VAS) for Pain at Rest (Post-Operative)

Time Point	Group PVB VAS Pain at Rest (Mean ± SD)	Group TEB VAS Pain at Rest (Mean ± SD)	p-value
60 min	2.80 ± 0.57	2.76 ± 0.59	0.8338
2 hour	2.78 ± 0.58	2.78 ± 0.58	0.8915
3 hour	2.86 ± 0.53	2.88 ± 0.52	0.8696
4 hour	2.90 ± 0.51	2.94 ± 0.47	0.6949
5 hour	3.00 ± 0.40	3.06 ± 0.42	0.4662
6 hour	3.12 ± 0.44	3.14 ± 0.45	0.7992

Table 5: Visual Analogue Score (VAS) for Pain at Coughing/Movement (Post-Operative)

Time Point	Group PVB VAS Pain at Coughing/Movement (Mean ± SD)	Group TEB VAS Pain at Coughing/Movement (Mean ± SD)	p-value
60 min	3.42 ± 0.54	3.48 ± 0.54	0.5228
2 hour	3.44 ± 0.54	3.46 ± 0.54	0.7880
3 hour	3.52 ± 0.54	3.52 ± 0.54	0.9229
4 hour	3.52 ± 0.54	3.56 ± 0.54	0.6379
5 hour	3.68 ± 0.51	3.76 ± 0.48	0.4539
6 hour	3.82 ± 0.44	3.84 ± 0.47	0.8552

Table 6: FEV1 (Postoperative)

Time Point	Group PVB FEV1 (Litre) (Mean ± SD)	Group TEB FEV1 (Litre) (Mean ± SD)	p-value
Pre-Op	2.44 ± 0.26	2.37 ± 0.17	0.1277
60 min	1.95 ± 0.26	1.85 ± 0.25	0.0672
2 hour	2.02 ± 0.28	1.92 ± 0.25	0.0714
3 hour	2.09 ± 0.27	2.00 ± 0.25	0.1193
4 hour	2.12 ± 0.27	2.05 ± 0.24	0.1801
5 hour	2.17 ± 0.26	2.10 ± 0.23	0.2263
6 hour	2.24 ± 0.24	2.17 ± 0.23	0.1493

Table 7: FVC (Postoperative)

Time Point	Group PVB FVC (Litre) (Mean ± SD)	Group TEB FVC (Litre) (Mean ± SD)	p-value
Pre-Op	2.77 ± 0.26	2.74 ± 0.17	0.6276
60 min	2.23 ± 0.26	2.13 ± 0.24	0.0602
2 hour	2.29 ± 0.27	2.19 ± 0.22	0.0605
3 hour	2.33 ± 0.26	2.24 ± 0.22	0.0651
4 hour	2.39 ± 0.24	2.30 ± 0.22	0.0671
5 hour	2.44 ± 0.24	2.36 ± 0.22	0.0733
6 hour	2.51 ± 0.22	2.43 ± 0.21	0.0801

Table 8: Peak Expiratory Flow Rate (Post-Operative)

Time Point	Group PVB PEFR (L/sec) (Mean ± SD)	Group TEB PEFR (L/sec) (Mean ± SD)	p-value
Pre-Op	5.44 ± 0.42	5.41 ± 0.58	0.7100
60 min	5.17 ± 0.63	5.00 ± 0.53	0.1446
2 hour	5.24 ± 0.63	5.08 ± 0.52	0.1754
3 hour	5.26 ± 0.63	5.14 ± 0.51	0.3052
4 hour	5.30 ± 0.61	5.16 ± 0.67	0.4785
5 hour	5.35 ± 0.60	5.16 ± 0.67	0.2395
6 hour	5.30 ± 0.58	5.22 ± 0.66	0.8177

Table 9: Side Effects in Both Groups

Side Effects	Group TEB (Present/Absent)	Group PVB (Present/Absent)
Nausea	6 / 44	1 / 49
Vomiting	3 / 47	1 / 49
Urinary Retention	8 / 42	0 / 50

Discussion

The present study investigated the analgesic efficacy and hemodynamic effects of Thoracic Epidural Block (TEB) and Paravertebral Block (PVB) in patients undergoing thoracotomy. The findings add to the existing body of literature on optimal post-thoracotomy pain management strategies.

Postoperative Pain Scores: The analgesic effectiveness, as measured by Visual Analogue Scale (VAS) scores in our study, did not significantly differ between the TEB and PVB groups. This observation aligns with Richardson et al. [14], who reported VAS scores at rest were better in the paravertebral group, although the differences were not statistically significant ($p>0.05$). Similarly, Davies et al. [15] in their meta-analysis involving 520 patients, found no significant difference in pain scores between the two techniques at various postoperative intervals ($P<0.05$). Conversely, Tamura et al. [17] reported significantly lower VAS scores in the epidural block group compared to paravertebral, with mean VAS scores significantly different throughout their observation period.

Hemodynamic Parameters: Regarding hemodynamics, our study highlighted significant differences at specific postoperative time points in the TEB group. This finding is consistent with Ganguly et al. [18], who observed a significant drop in mean arterial pressure in the thoracic epidural group during the first hour post-administration. In contrast, Casati et al. [16] reported a more pronounced reduction in systolic arterial pressure in the TEB group, with clinically relevant hypotension observed in 19% of their TEB group compared to none in the PVB group (P=0.04).

Lung Function: Our study revealed lower FEV1 and FVC values in the TEB group compared to PVB postoperatively, although these differences were not statistically significant. Gulbahar et al. [19] reported similar findings, with no significant differences in postoperative FEV1 and PEFR between both groups (p-values ranging from 0.492 to 0.758). However, Kaiser et al. [20] found the PVB group to have significantly better pulmonary function in the first 24 hours postoperatively (FVC 46.8% for PVB vs. 39.3% for TEB, P<0.05).

Side Effects: In terms of side effects, our study indicated a higher incidence of nausea, vomiting and urinary retention in the TEB group. This is in line with the findings of Mahmoud et al. [21], who noted a significant difference in urinary retention between the TEB and PVB groups.

Overall, our findings contribute to the growing body of evidence that suggests both TEB and PVB are effective in managing post-thoracotomy pain, with each technique presenting its unique profile in terms of pain control, hemodynamic stability, lung function preservation and side effect incidence.

Conclusion

Our study meticulously compared the analgesic efficacy and hemodynamic effects of Thoracic Epidural Block (TEB) and Paravertebral Block (PVB) in patients undergoing thoracotomy. The results indicate that both TEB and PVB are effective in managing post-thoracotomy pain without significant differences in pain scores. Specifically, the Visual Analogue Scale (VAS) scores for pain at rest and during coughing were comparable between the two groups at all assessed time points (p>0.05).

Hemodynamically, the TEB group exhibited significant variations at certain postoperative intervals, with a noted decrease in mean arterial pressure at 15 minutes (p=0.0040), 30 minutes (p=0.0001) and 60 minutes (p=0.0136) postoperatively, and a lower heart rate at 15, 30 and 60 minutes. These findings suggest a more pronounced hemodynamic effect associated with TEB. In terms of lung function, both groups showed a decrease in FEV1 and FVC values postoperatively; however, these differences were not statistically significant, indicating that neither technique adversely affected postoperative pulmonary function significantly. The study also noted a higher incidence of nausea, vomiting and urinary retention in the TEB group, which necessitates consideration in clinical decision-making.

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