Original Article

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Can Intercostal Nerve Blockade be an Effective Alternative to Thoracic Epidural Analgesia for Acute Post-thoracotomy Pain Relief?

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Abstract

Introduction: The pain that occurs the following a thoracotomy procedure, which is also known as post-thoracotomy pain, is quite commonly very severe and a major source of concern in the post-operative period. This study was designed to evaluate the effectiveness of intercostal nerve blockade as compared to thoracic epidural analgesia to alleviate acute post-thoracotomy pain.

Materials and Methods: A total of 60 patients undergoing elective pulmonary resection through a posterolateral thoracotomy were randomly allocated to receive either single-dose epidural analgesia using 0.2% ropivacaine (Group E, $n = 30$) or temporary intercostal nerve blockade using 0.2% ropivacaine (Group I, $n = 30$). Adequacy of analgesia was assessed in post-operative period using a visual analog score at 30 min interval.

Results and Observation: Duration of static analgesia (analgesia at rest) in Group E was 214 ± 10.2 min and in Group I was 210 ± 8.35 min, but the difference is statistically insignificant ($P = 0.1019$). Duration of dynamic analgesia (analgesia at coughing) in Group E was 200 ± 17.89 min and in Group I was 193 ± 16.76 min, but the difference is statistically insignificant (P - 0.1233).

Conclusion: A value of 10 ml of 0.2% ropivacaine in thoracic epidural route provides almost equal ($P > 0.05$) duration of post-operative static and dynamic analgesia as compared to 20 ml of 0.2% ropivacaine in intercostal nerve blockade in post-thoracotomy patients in early post-operative period.

Key words: Intercostal nerve blockade, Post-thoracotomy pain, Ropivacaine, Thoracic epidural analgesia, Visual analog score

INTRODUCTION

Post-thoracotomy pain is very severe, probably the most severe pain experienced after surgery. Acute post-thoracotomy pain is due to skin and muscle injury, retraction, resection, or fracture of ribs, dislocation of costovertebral and costochondral joints, injury of intercostal nerves and further irritation of the pleura by chest tubes.[1] Treatment of acute post-thoracotomy pain is particularly important not only to keep the patient comfortable but also to minimize pulmonary complications.[1] Suboptimal pain relief not only will lead to increased patient suffering but also to increased morbidity after operation. In particular, poor cough and clearance of secretions may lead to atelectasis and pneumonia, which additionally prolongs immobility, and may lead to complications such as deep vein thrombosis and pulmonary embolism.[1] Poorly treated acute post-thoracotomy pain may lead to chronic post-thoracotomy pain syndrome.[2]

Many methods of acute post-thoracotomy pain management have been tried with varied success, for example Intercostal nerve block, intrapleural analgesia, cry analgesia, lumbar epidural, thoracic epidural, paravertebral block, intravenous (IV) narcotics, intrathecal or epidural narcotics, non-steroidal anti-inflammatory drugs (NSAIDs), and transcutaneous nerve stimulation.[3,4]

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In many centers, epidural anesthesia has emerged as the gold standard for pain control. However, this method is not suitable for all patients specially in those with altered coagulation profile and may be associated with potential risks such as dural perforation, bleeding, infection, hypotension, and urinary retention.[5-7] There are also other potential problematic issues with epidural pain control, such as delaying the start of an operative procedure, technical failures of 13-15%[8,9] and the costs of post-operative pain management by a separate pain team. Another method of pain control, which has gained popularity in some centers, is the use of intercostal nerve blockade.[10,11] As with epidural anesthesia, this method allows local administration of drugs to the pain causing anatomic region, but potentially with lower risks and discomfort to the patient. There may also be fewer delays in surgery, and the technical failure rate should be lower since it is placed under direct vision. Moreover, it is much more cost-effective than thoracic epidural analgesia. The present study is designed to compare visual analog scale (VAS) in patients receiving thoracic epidural analgesia versus patients receiving intercostal nerve blockade for acute post-thoracotomy pain relief.

MATERIALS AND METHODS

After obtaining Institutional ethical committee clearance, this prospective, randomized, single-blinded, single hospital study included 60 cases (69 cases enrolled for the study, of which 60 cases completed the study as per protocol analysis) of both sexes, aged 18 years or more, posted for elective thoracotomy. An informed consent was obtained from each participating patient. The patients were randomly divided into Group E and Group I of 30 patients each. Randomization was by sequential allocation of eligible patients to computer generated random numbers. An anesthesiologist who was not involved in the study performed the analysis of variables and recording of data. The blinding was opened only after the clinical phase was over.

The patients were kept nil orally overnight before surgery. Diazepam 0.1 mg/kg and ranitidine 3 mg/kg were given orally on the night before surgery. On arrival to the operation theatre, an IV line was secured with 18 G cannula and lactated ringers solution was started. All anesthetic equipment were checked. Standard American Society of Anesthesiologists monitors attached to the patient and invasive blood pressure monitoring established and samples taken for arterial blood gases, serum electrolytes, etc. In all patients of Group E, a 20 G epidural catheter through 18 G Tuohy needle was placed in sitting position under aseptic and antiseptic precautions at a mid-thoracic level (T4-T7) before the induction of general anesthesia. Patients of both the Group E and I were pre-medicated with glycopyrrolate (0.2 mg) IV, midazolam (1-2 mg) IV, palonosetron (0.075 mg) IV, and fentanyl (1 mcg/kg) IV. After 3 min of pre-oxygenation, patients were induced with propofol (2-3 mg/kg) IV. Neuromuscular block was achieved with vecuronium bromide (0.1 mg/kg) IV, followed by an intubation with an adequate size endotracheal tube. Anesthesia was maintained with isoflurane in oxygen and nitrous oxide (4:2) along with divided doses of vecuronium bromide. Intraoperative analgesia was provided by paracetamol 1000 mg IV infused over 15 min and fentanyl citrate infused at a rate of 0.5 mcg/Kg/h.

Unilateral thoracotomy was performed through the fifth or sixth intercostal space via a poster lateral incision. Toward the end of surgery, at the time of rib approximation, patients of Group E (n = 30) received a 10 ml bolus of 0.2% ropivacaine through the epidural catheter and patients of Group I (n = 30) received 20 ml of 0.2% ropivacaine to block 5 intercostal nerves (4 ml per nerve) near the angle of ribs; 1 nerve at the level, 2 nerves above and 2 below the level of thoracotomy using a 22 G needle. The intercostal nerve block was given by the operating surgeon. The infusion of fentanyl was terminated before the initiation of epidural analgesia in all patients of Group E and before the institution of the intercostal nerve block in all patients of Group I. After skin closure, the neuromuscular blockade was reversed with a combination of neostigmine and glycopyrrolate and the patient was extubated and shifted to intensive care unit for 24 h. Analgesia was assessed every 30 min using a (VAS; 0 mm = no pain and 100 mm = worst pain imaginable) both at rest and during coughing minutes till 1 h after rescue analgesics were started. Duration of post-operative analgesia was deemed from the time of extubation till VAS score became ≥4. Rescue analgesics as per departmental protocol (fentanyl patch [25 mcg/h], and injection diclofenac 75 mg IV) were started once the VAS >4 in both groups and the timing of administration of this medication was recorded. No medication was given through the epidural catheter after the initial bolus dose of 10 ml ropivacaine 0.2% and catheter were removed after 24 h.

The data were collected by an independent anesthetist in the post-operative care unit blinded for the technique used for each patient.

Statistical Analysis of Data

The data were entered into MS Excel spreadsheets and statistical analyses were done by using "GraphPad InStat - Version 3" software. Data were presented as a mean ± standard deviation for demographic data and duration of analgesia, and compared by "unpaired Student's t-test." A $P < 0.5$ was considered as statistically significant.

RESULTS AND OBSERVATION

Demographic Parameters

Demographic data of 60 patients are compared in Table 1. There is no statistically significant difference between the groups in terms of age, weight, height, gender distribution, and duration of surgery.

VAS Score at Rest

As shown in Figures 1 and 2, most of the patients in both the groups attained VAS score (at rest) 4 at 210 min. As shown in Figure 3, both the groups showed almost similar variation in median VAS score at rest in post-operative period. Median VAS score at rest became 4 and 7 at 210 and 240 min, respectively. As soon as patients feel pain (VAS score ≥4) rescue analgesics were started, so the median VAS score came down to 5 at 270 min. As shown in Figure 4, duration of static analgesia (analgesia at rest) in Group E was 214 ± 10.2 min and in Group I was 210 ± 8.35 min, but the difference is statistically insignificant ($P = 0.1019$).

VAS Score at Coughing

As shown in Figures 5 and 6, most of the patients in both the groups attained VAS score (at coughing) 4 at 210 min and few patients at 180 min. As shown in Figure 7, both the groups showed almost similar variation in median VAS score at coughing in post-operative period. Median VAS score at coughing became 4 and 8 at 210 and 240 min, respectively. As soon as patients feel pain (VAS score ≥4) rescue analgesics were started, so the median VAS score at coughing came down to 7 at 270 min. As shown in Figure 8, duration of dynamic analgesia (analgesia at

Table 1: Comparison of demographic parameters

Demographic parameters	Group E	Group I	*P* value
Age (years)	37.57±12.78	32.47±10.93	0.1021
Weight (kg)	45±7.62	42.1±8.53	0.1702
Height (cm)	145.27±10.1	140.3±10.65	0.0687
Sex (male:female)	20:10	23:07	
ASA physical status I/II (n)	25:5	24:6	
Duration of surgery (min)	95.5±25.3	104±16.1	0.1260
Surgical procedures			
Lobectomy	2	4	
Decortication	19	17	
Pericardiectomy	3	2	
Closed mitral valvotomy	3	4	
Tumor excision	2	1	
Foreign body removal	1	2	

ASA: American Society of Anesthesiologists

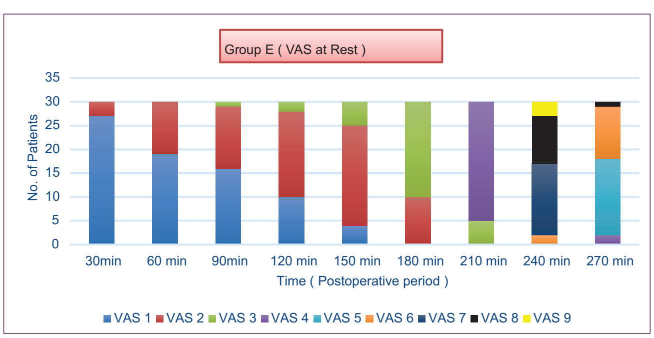

Figure 1: Distribution of patients of Group E according to visual analog scale score at rest at 30 min interval in post-operative period

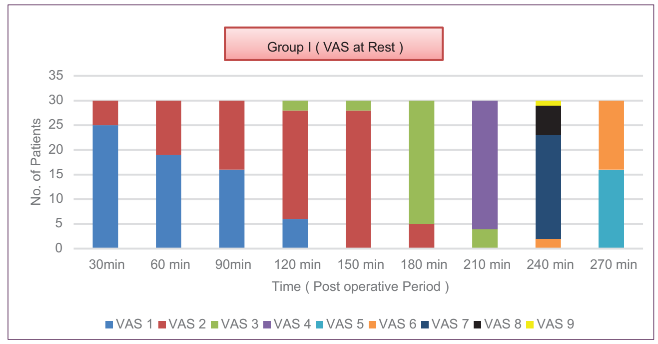

Figure 2: Distribution of patients of Group I according to visual analog scale score at rest at 30 min interval in post-operative period

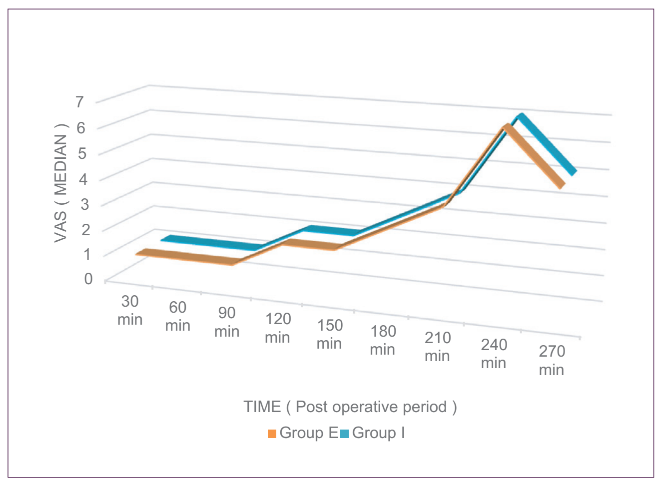

Figure 3: Comparison of variation of median visual analog scale score at rest between Group E and I at 30 min interval in post-operative period

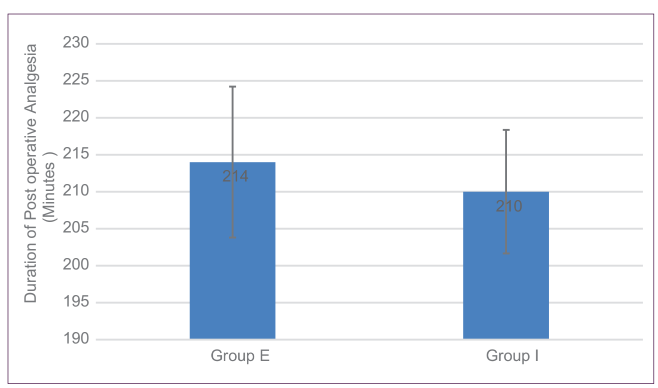

Figure 4: Comparison of duration of static analgesia between Group E and I in post-operative period

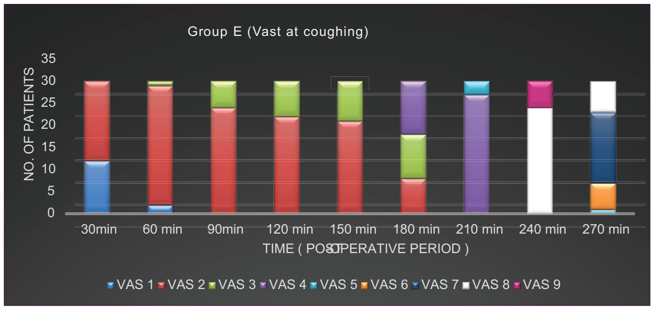

Figure 5: Distribution of patients of Group E according to visual analog scale score at coughing at 30 min interval in post-operative period

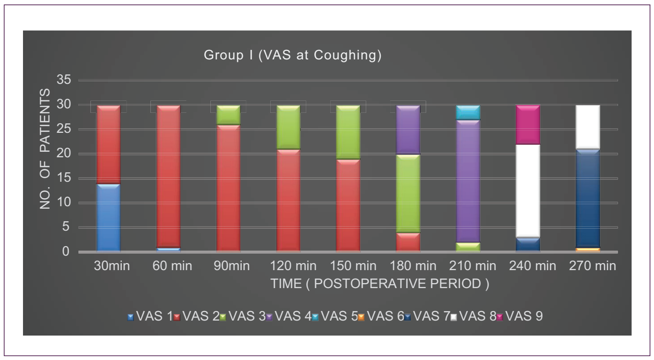

Figure 6: Distribution of patients of Group I according to visual analog scale score at coughing at 30 min interval in post-operative period

coughing) in Group E was 200 ± 17.89 min and in Group I was 193 ± 16.76 min, but the difference is statistically insignificant ($P = 0.1233$).

The *post hoc* power analysis of our study revealed a power of 90% with an α of 0.05 (two-tailed) and a β of 0.10.

DISCUSSION

This study was designed to evaluate the effectiveness of intercostal nerve blockade as compared to thoracic epidural analgesia to alleviate acute post-thoracotomy pain. To make the analgesic efficacy comparable between Group E and Group I, single dose thoracic epidural analgesia was performed in Group E and single dose intercostal block was performed in Group I. On the basis of animal and volunteer studies, it was concluded that ropivacaine seems to be less neurotoxic and cardiotoxic than bupivacaine.[12] Epidural ropivacaine causes less motor block than bupivacaine.[13,14] Hence, ropivacaine was selected for the study.

About 0.2% ropivacaine was found adequate for thoracic epidural analgesia and intercostal nerve block for post-

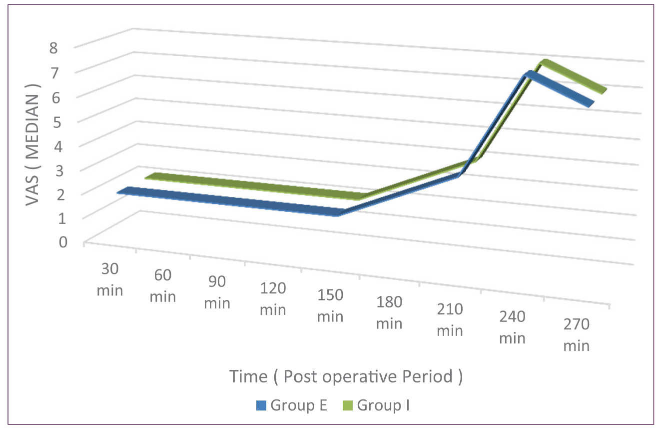

Figure 7: Comparison of variation of Median VAS score at coughing between Group E and I at 30 minutes interval in postoperative period

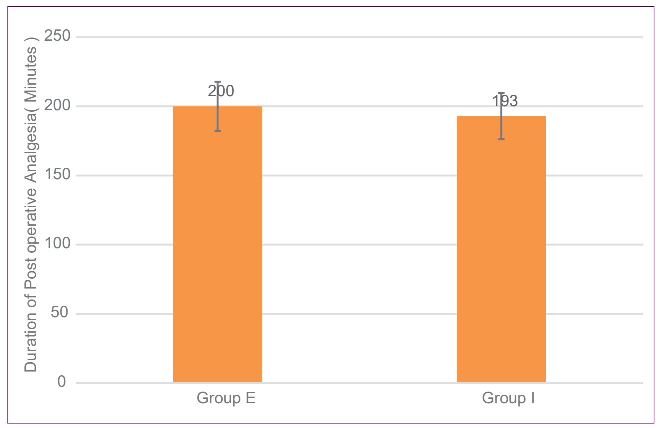

Figure 8: Comparison of duration of dynamic analgesia between Group E and I in post-operative period

thoracotomy pain relief.[15,16] 0.8 ml/thoracic segment of local anesthetic solution is required for thoracic epidural analgesia and anesthesia.[17,18] Hence, we used 10 ml of local anesthetic solution to cover thoracic dermatomes. For each intercostal nerve blockade, we used 4 ml local anesthetic solution,[19] to block 5 intercostal nerve, i.e., 1 nerve at the level of incision, 2 above it and 2 below it.[20] Although epidural opioid improves the duration and quality of block when used as an adjuvant with a local anesthetic, it carries the risk of respiratory depression, sedation, pruritus, nausea, urinary retention. This study did not use epidural opioids, which could have led to alteration of pain scores seen in previous reports.[21,22]

In our study, we found that 10 ml of 0.2% ropivacaine in thoracic epidural (epidural catheter placed between T4 and T7) provide duration of analgesia of 214 ± 10.2 min while the patient is at rest (static analgesia) and of 200 ± 17.89 min while the patient coughs (dynamic analgesia) in immediate post-operative period in post-thoracotomy patients. Studies show that 0.2-0.75% ropivacaine provides 180-350 min of analgesia when used in epidural route with an onset within 15-20 min.[23,24]

In our study, we found that 20 ml 0.2% ropivacaine in provided 210 ± 8.35 min of static analgesia and 193 ± 16.76 min dynamic analgesia in immediate post-operative period in post-thoracotomy patients when used for intercostal nerve blockade of 5 nerves (4 ml/nerve), i.e., 1 at the site of incision, 2 above it and 2 below it. Studies show that 0.2-0.5% ropivacaine provides 240-420 min of analgesia when used for peripheral nerve blocks with an onset within 5-20 min.[23,24]

About 10 ml of 0.2% ropivacaine in thoracic epidural route provides almost equal (P - >0.05) duration of post-operative static and dynamic analgesia as compared to 20 ml of 0.2% ropivacaine in intercostal nerve blockade in post-thoracotomy patients.

Till now no previous study till has compared single dose thoracic epidural analgesia with single dose intercostal nerve blockade for acute post-thoracotomy pain relief.[21,25-35]

Previous studies mostly compared continuous thoracic epidural analgesia with either single dose intercostal nerve blockade[25-34] or continuous intercostal block.[21,35]

Asantila *et al.,*[25] compared five methods for post-thoracotomy pain treatment. In their study continuous extradural local anesthetic block seemed to be somewhat better than a single intrathoracic intercostal block, but the difference was not statistically significant. Sabanathan *et al.*,[36] demonstrated in a prospective double-blind trial that continuous extrapleural intercostal nerve block with bupivicaine provided significantly better pain relief and pulmonary function after thoracotomy. Their results are difficult to compare with ours because of differences in methodology.

Most of the previous studies found continuous thoracic epidural analgesia superior to single dose intercostal nerve blockade for acute post-thoracotomy pain relief.[25,28-34,35]

Few studies concluded intercostal nerve blockade to be more or as effective as thoracic epidural analgesia for post-thoracotomy pain management during early post-operative period.[21,26,27]

Perttunen *et al.*,[26] found Intercostal nerve block to be more effective than epidural analgesia to decrease dynamic pain in the early post-operative period following thoracotomy.

Sanjay *et al.*,[29] compared thoracic epidural analgesia with intercostal nerve block for acute post-thoracotomy pain relief. They found that pain scores were similar in both the groups for the first 4 h after surgery. Thereafter, the pain scores were significantly higher (P < 0.05) in intercostal group as compared tothoracic epidural group for the remainder of the observation period. The minor differences in outcome between our study and this study are probably due to difference in local anesthetic used and methodology. They used 0.25% bupivacaine and we used 0.2% ropivacaine. They used VAS and observer verbal rating score at 1 h interval, and we used VAS at 30 min interval. They used continuous thoracic epidural analgesia, but we used single dose thoracic epidural analgesia.

Fentanyl patch (25 mcg/h) was applied and injection diclofenac (75 mg/1 ml) were started once the VAS >4 in both groups, could not provide same quality of analgesia as provided either by thoracic epidural analgesia or by intercostal nerve block alone, as evident by median VAS of 5 at rest at 270 min and 7 at coughing at 270 min in both the groups, i.e., 1 h after the rescue analgesic started.

As shown in Table 2, incidence of ipsilateral shoulder tip pain is same in both the groups, i.e. 3/30 or 10%. Previous studies have reported incidence of ipsilateral shoulder tip pain following thoracotomy to be 31-85%.[37-43] The low incidence of ipsilateral shoulder tip in our study is probably due to only 4½ h of post-operative observation, which is far less in comparison to several days of post-operative observation in previous studies. 10% incidence of urinary retention was seen in Group E, but no such case reported in Group I.

Limitation of the study was that we did not investigate about pulmonary function test of the patients in post-operative period.

CONCLUSION

It is of utmost importance to reduce the incidence of pain following thoracotomy. Both techniques studied

Table 2: Comparison of complications in Group E and Group I in post-operative period

Complications	Group E	Group I
Hypotension	1	0
Respiratory depression	0	0
Bradycardia	1	0
Ipsilateral shoulder tip pain	3	3
Urinary retention	3	0
Local anesthetic systemic toxicity	0	0

by us provide equal duration and quality analgesia in the immediate post-operative period and either technique is superior to parenteral analgesia by opioids and NSAIDs. Hence, it can be recommended that intercostal nerve block is an effective alternative to thoracic epidural analgesia for acute post-thoracotomy pain relief in the early post-operative period, for those patients who do not qualify for epidural analgesia due to technical failures or contraindications.

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