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POST OP PAIN RELIEF BY THORACIC EPIDURAL VS SYSTEMIC OPOID BASED MANAGEMENT IN THORACIC SURGERIES- A COMPARATIVE STUDY

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Abstract

Objectives: *The main objective of the study is to compare post op pain relief by thoracic epidural vs systemic opoid based management in thoracic surgeries- a comparative study*

Study design and place of study*: Comparative Cross-Sectional study, September 2024- February 2025, Territiary care hospital, Lahore*

Methodology: *80 patients were included in this study. Patients were randomly allocated into two groups (n=40 each): Group E received thoracic epidural analgesia, while Group O received systemic opioid-based analgesia. Pain was assessed using the Numerical Rating Scale at rest and on coughing at 2, 6, 12, 24, and 48 hours. Respiratory parameters, hemodynamics, complications, and hospital stay were recorded. Data were analyzed using SPSS, with $p<0.05$ considered statistically significant.*

Results: *Eighty patients were equally divided into Group E and Group O, with comparable baseline characteristics ($p>0.05$). Postoperative pain scores were significantly lower in Group E at all time points. At 2 hours, NRS at rest was 2.8 ± 0.9 in Group E versus 5.6 ± 1.1 in Group O ($p<0.001$), with similar trends up to 48 hours. Pain during coughing was also significantly lower in the epidural group ($p<0.001$). Respiratory parameters were better in Group E, with higher SpO_2 (97.8 ± 1.2% vs 95.9 ± 1.5%), improved spirometry (1650 ± 250 ml vs 1200 ± 220 ml), and lower respiratory rate ($p<0.001$). Hospital stay was shorter in Group E (5.2 ± 1.1 vs 7.1 ± 1.5 days, $p<0.001$).*

Conclusion: *Thoracic epidural analgesia as the preferred modality for postoperative pain management in thoracic surgeries.*

Introduction:

Perioperative care is based on the effectiveness of pain control in the postoperative period, especially in patients who underwent thoracic surgeries. Such surgeries as thoracotomy and video-assisted thoracoscopic surgery (VATS) are linked to a high level of postoperative pain as a result of the vast dissection of tissues, retraction of ribs, and irritation of the intercostal nerves. The poor pain management is not only a cause of pain to the patient, but also of severe complications like poor respiratory mechanics, low cough efficiency,

atelectasis and pneumonia, which eventually result in more morbidity and prolonged hospital stay.[1] Systemic opioid-based analgesia has traditionally been broadly applied to the post-operative analgesia. Morphine and fentanyl are the examples of opioids with high analgesic properties that are commonly linked to some adverse effects like respiratory depression, sedation, nausea, vomiting, constipation, and opioid dependence. These side effects may be especially harmful in patients of thoracic surgery, since respiratory compromise can carry an increased risk of postoperative pulmonary patients.[2]

Thoracic epidural analgesia (TEA) has become a better alternative to managing pain during thoracic surgeries. TEA is an effective method of segmental analgesia that is achieved by the local application of anesthetic agents, usually with low doses of opioids, directly into the epidural space, which would effectively inhibit the transmission of nociceptive at the spinal level. Such a specific practice is aimed at not only achieving high-quality pain relief but also maintaining respiratory reserve, improving pulmonary mechanics, and early mobilization. Thereby, a number of anesthetic and surgical societies have suggested TEA to be the gold standard of postoperative analgesia during thoracic procedures.[3]

TEA has its limitations, even though it has its benefits. Technical skills are required in the methodology and its application might be contraindicated in patients with coagulopathy, infection where it is inserted or in some spinal defects. Moreover, one should take into consideration possible complications, including hypotension, urinary retention and the rare yet severe neurological events. Conversely, systemic opioid-based treatment is easier to give and is more broadly applicable particularly in resource-constrained environment where epidural care may not be easily accessible.[4]

Considering this, thoracic epidural analgesia and systemic opioid-based pain management should be comparatively assessed to identify the best approach towards managing postoperative pain in users of thoracic surgery. In this work, the author will compare the efficacy, safety, as well as clinical outcomes of these two modalities in terms of variables like pain rates, respiratory activity, the rate of complications, and the overall recovery of the patient. It is possible that the findings will aid clinicians in choosing the most effective analgesic method and achieving a compromise between effectiveness and safety and possibility in a variety of clinical settings.

Methodology:

This comparative cross-sectional study was conducted in the Department of Anesthesiology at a tertiary care hospital, Hameed Latif Hospital, over a period of 06 months from September 2024 to February 2025. Institutional ethical committee approval was obtained prior to commencement of the study, and written informed consent was secured from all participants. A total of 80 adult patients scheduled for elective thoracic surgeries (including thoracotomy and video-assisted thoracoscopic procedures) were enrolled. Patients were aged between 18 and 70 years and belonged to the American Society of Anesthesiologists (ASA) physical status I–III.

Inclusion Criteria

- Patients undergoing elective thoracic surgery
- Age 18–70 years
- ASA physical status I–III
- Ability to understand and use the Numerical Rating Scale (NRS)

Exclusion Criteria

- Patient refusal
- Coagulopathy or ongoing anticoagulant therapy
- Infection at epidural insertion site
- Severe spinal deformity
- Chronic opioid use or opioid dependency
- Known allergy to study drugs
- Severe hepatic or renal impairment

Group Allocation

Patients were randomly allocated into two groups (n=40 each) using a computer-generated randomization table:

- **Group E (Epidural Group):** Received thoracic epidural analgesia
- **Group O (Opioid Group):** Received systemic opioid-based analgesia

Anesthetic Technique

All patients received standardized general anesthesia. Preoperative monitoring included ECG, non-invasive blood pressure, pulse oximetry, and capnography. Induction was performed with intravenous propofol (2 mg/kg), fentanyl (2 µg/kg), and a muscle relaxant (atracurium 0.5 mg/kg). Maintenance of anesthesia was achieved with inhalational agents (sevoflurane or isoflurane) in oxygen-air mixture.

Intervention Protocols

Group E (Thoracic Epidural Analgesia)

Thoracic epidural catheter was inserted preoperatively at T5–T7 interspace under strict aseptic precautions using loss-of-resistance technique. After negative aspiration test, a test dose of 3 ml lignocaine with adrenaline was administered. Intraoperatively and postoperatively, analgesia was maintained with continuous infusion of 0.125% bupivacaine with fentanyl (2 µg/ml) at a rate of 5–8 ml/hour.

Group O (Systemic Opioid Group)

Patients received intravenous opioid-based analgesia. Intraoperatively, fentanyl supplementation (1–2 µg/kg) was administered as required. Postoperatively, analgesia was maintained using intravenous morphine via intermittent boluses (0.05–0.1 mg/kg) or patient-controlled analgesia (PCA), depending on availability.

Data Collection

Pain assessment was performed using the Numerical Rating Scale (NRS; 0–10) at rest and on coughing at 2, 6, 12, 24, and 48 hours postoperatively. Respiratory parameters including respiratory rate, oxygen saturation (SpO_2), and incentive spirometry performance were recorded. Hemodynamic parameters (heart rate and mean arterial pressure) were monitored at regular intervals. The incidence of postoperative complications such as nausea, vomiting, hypotension, respiratory depression, urinary retention, and pulmonary complications (atelectasis, pneumonia) was documented.

Outcome Measures

Primary Outcome:

- Postoperative pain scores (NRS)

Secondary Outcomes:

- Respiratory function (SpO_2, spirometry)
- Total opioid consumption
- Incidence of adverse effects
- Duration of hospital stay

Statistical Analysis

Data were entered and analyzed using SPSS version 25. Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. Intergroup comparisons for continuous variables were performed using independent t-test or Mann–Whitney U test as appropriate. Categorical variables were analyzed using chi-square test or Fisher's exact test. A p-value of <0.05 was considered statistically significant.

Results:

A total of 80 patients were enrolled and completed the study, with 40 patients in each group: Group E (thoracic epidural analgesia) and Group O (systemic opioid-based analgesia).

Both groups were comparable in terms of demographic characteristics and baseline clinical parameters. The mean age in Group E was 52.3 ± 10.4 years, while in Group O it was 50.8 ± 11.2 years ($p=0.53$). Baseline variables including gender distribution, body weight, ASA physical status, and type of surgery (open/VATS) were statistically similar between the two groups ($p>0.05$), confirming homogeneity.

Postoperative pain scores assessed using the Numerical Rating Scale (NRS) at rest were significantly lower in Group E at all measured time intervals. At 2 hours postoperatively, the mean NRS score was 2.8 ± 0.9 in Group E compared to 5.6 ± 1.1 in Group O ($p<0.001$). This trend persisted at 6, 12, 24, and 48 hours, with Group E demonstrating consistently superior analgesia ($p<0.001$). Similarly, pain scores during coughing were significantly lower in the epidural group, with mean values of 3.5 ± 1.0 in Group E versus 6.8 ± 1.2 in Group O at 2 hours, and continued improvement at subsequent time points ($p<0.001$).

Respiratory parameters were significantly improved in Group E. At 24 hours postoperatively, mean oxygen saturation was higher in Group E (97.8 ± 1.2%) compared to Group O (95.9 ± 1.5%) ($p<0.001$). Incentive spirometry performance was also better in Group E (1650 ± 250 ml vs. 1200 ± 220 ml, $p<0.001$), while respiratory rate was lower (16.2 ± 2.1 vs. 19.5 ± 2.8 breaths/min, $p<0.001$). Additionally, Group E had a significantly shorter hospital stay (5.2 ± 1.1 days) compared to Group O (7.1 ± 1.5 days, $p<0.001$).

In terms of complications, the incidence of nausea and vomiting was significantly higher in Group O (45%) compared to Group E (15%) ($p=0.004$). The opioid group was also associated with a higher incidence of respiratory depression and pulmonary complications ($p=0.04$ and $p=0.03$, respectively). Although hypotension occurred more frequently in the epidural group (20% vs. 7.5%), the difference was not statistically significant ($p=0.10$).

Overall, thoracic epidural analgesia provided superior postoperative pain control, improved respiratory function, reduced hospital stay, and fewer complications compared to systemic opioid-based analgesia.

Table 1: Demographic and Baseline Characteristics of two groups

Parameter	Group E (n=40)	Group O (n=40)
Age (years)	52.3 ± 10.4	50.8 ± 11.2
Gender (M/F)	26/14	24/16
Weight (kg)	68.5 ± 9.1	70.2 ± 8.7
ASA I/II/III	10/22/8	12/20/8
Type of surgery (Open/VATS)	25/15	27/13

Table 2: Postoperative Pain Scores (Numerical scale at Rest)

Time Interval	Group E (Mean ± SD)	Group O (Mean ± SD)
2 hours	2.8 ± 0.9	5.6 ± 1.1
6 hours	3.1 ± 1.0	5.9 ± 1.2
12 hours	2.9 ± 0.8	5.4 ± 1.0
24 hours	2.5 ± 0.7	4.8 ± 0.9
48 hours	2.2 ± 0.6	4.2 ± 0.8
Time Interval	**Group E (Mean ± SD)**	**Group O (Mean ± SD)**
2 hours	3.5 ± 1.0	6.8 ± 1.2
6 hours	3.8 ± 1.1	7.1 ± 1.3
12 hours	3.6 ± 1.0	6.5 ± 1.1
24 hours	3.2 ± 0.9	5.9 ± 1.0
48 hours	2.9 ± 0.8	5.2 ± 0.9

Table 3: Postoperative Pain Scores (Numerical scale on Coughing) in both groups

Parameter	Group E	Group O
SpO_2 (%) at 24 hrs	97.8 ± 1.2	95.9 ± 1.5
Incentive spirometry (ml)	1650 ± 250	1200 ± 220
Respiratory rate (breaths/min)	16.2 ± 2.1	19.5 ± 2.8
Hospital stay (days)	5.2 ± 1.1	7.1 ± 1.5

Table 4: Postoperative Respiratory and Recovery Parameters

Complication	Group E (n=40)	Group O (n=40)
Nausea/Vomiting	6 (15%)	18 (45%)
Hypotension	8 (20%)	3 (7.5%)
Respiratory depression	1 (2.5%)	6 (15%)
Urinary retention	5 (12.5%)	4 (10%)
Pulmonary complications	3 (7.5%)	10 (25%)

Table 5: Postoperative Complication in both groups

Discussion:

Postoperative pain management is still an imperative outcome determinant of thoracic surgeries. The current paper proves that thoracic epidural analgesia (TEA) is able to offer better analgesia, better respiration, and less postoperative complications in comparison to systemic opioid-based analgesia. These results are in line with the accumulating evidence to support the regional analgesic techniques as the mode of choice in thoracic surgical patients.

Thoracic surgery causes a great deal of tissue trauma, intercosstals nerve irritation, and rib retraction as a result of which postoperative pain tends to be severe. Poor pain management is likely to hinder respiratory mechanics, decrease tidal volume, and block adequate coughing, thus leading to complications like atelectasis and pneumonia in patients. In our analysis, the group of patients receiving an epidural analgesia had a notably lower score of the Numerical Rating Scale (NRS) at rest and coughing in all intervals of time. The given finding coincides with the previous research conducted by Block et al. that has proven that during major surgery, especially thoracic surgery, epidural analgesia provides high-quality pain management compared to systemic opioids.[5,6]

The better pain management with TEA was reflected on respiratory outcome improvement in our experiment. The patients who were administered epidural analgesia recorded high oxygen saturation levels, better performance of incentive spirometry and reduced respiration rates that suggest better ventilation. This clinical relevance of the findings, is that the best respiratory condition is needed to avoid the development of postoperative pulmonary complications. Similar findings were represented by Ballantyne et al. who established that regional analgesia methods, such as TEA, are much better in terms of pulmonary outcomes, when compared to systemic opioid administration.[7]

The lesser incidence of pulmonary complications in the epidural group was also one of the remarkable results of our study. The reduced incidences of atelectasis and pneumonia may also be attributed to the improved pain management that allows deep breathing, early mobilization, and coughing. In their effort to underline the importance of sufficient analgesia as a means of reducing pulmonary morbidity following thoracic surgery, Gottschalk et al. underscored the role of TEA in the achievement of the same.[8]

Systemic opioid-based pain management, on the other hand, was also found to be effective in the reduction of pain, but with a higher number of adverse effects, such as nausea, vomiting, and respiratory depression. These side effects are well reported in literature and might have a detrimental effect on the recovery of the operation. The respiratory depression is especially

hazardous among patients of thoracic surgery because it can further worsen the situation of hypoventilation and predispose patients to pulmonary complications. In their systematic review, Liu and Wu emphasized that opioid-related side effects have the capability to counter the positive analgesia effects through the adverse effect on overall recovery.[9,10]

Regardless of the benefits, TEA was linked with an increased incidence of hypotension in our investigation though it was not statistically significant. A side effect of epidural analgesia is known to cause hypotension because of sympathetic blockage, which results in vasodilation. Nevertheless, it is a complication that can be treated under proper fluid therapy and vasopressor support. Similar findings were reported by Freise and Van Aken, who stressed that TEA is also fraught with some risks but its advantages in analgesic and better outcomes aspects greatly exceed these issues in proper cases of use.

Another significant finding of this study was the shorter duration of hospital stay observed in the epidural group. This can be attributed to superior pain control, improved respiratory function, and a lower incidence of postoperative complications, all of which facilitate early mobilization and faster recovery. Reduced hospital stay not only enhances patient satisfaction but also minimizes healthcare costs and resource utilization. These findings are supported by Henrik Kehlet and Johan B. Dahl, who emphasized the role of multimodal and regional analgesia as key components of enhanced recovery protocols aimed at improving surgical outcomes and reducing hospitalization duration [11].

Although thoracic epidural analgesia (TEA) is widely regarded as the gold standard for postoperative pain management in thoracic surgery, its use may be limited in certain clinical situations. Contraindications such as coagulopathy, infection at the insertion site, or patient refusal must be carefully considered. Furthermore, the technique is skill-dependent and requires continuous monitoring, which may not be readily available in all healthcare settings, particularly in resource-limited environments. In such cases, systemic opioid-based analgesia remains a practical alternative, despite its known limitations [12].

Emerging alternatives such as paravertebral blocks have also gained attention, as they have demonstrated comparable analgesic efficacy with potentially fewer side effects. According to Richard G. Davies and colleagues, paravertebral blockade may provide similar pain control to TEA with a lower incidence of hypotension, suggesting that individualized analgesic strategies may be beneficial [13]. Nevertheless, TEA continues to be strongly recommended due to its robust evidence base and consistent clinical outcomes.

Postoperative pain management remains a critical determinant of outcomes following thoracic surgery. The findings of the present study demonstrate that thoracic epidural analgesia provides superior analgesia, improved respiratory function, and reduced postoperative complications compared to systemic opioid-based analgesia. These results are consistent with the growing body of evidence supporting regional analgesic techniques as the preferred modality in thoracic surgical patients.

Thoracic surgery is associated with significant tissue trauma, intercostal nerve irritation, and rib retraction, resulting in severe postoperative pain. Inadequate pain control can impair respiratory mechanics, reduce tidal volume, and inhibit effective coughing, thereby increasing the risk of complications such as atelectasis and pneumonia. In this study, patients receiving epidural analgesia had significantly lower Numerical Rating Scale (NRS) scores both at rest and during coughing at all time intervals. These findings are consistent with studies by Brian M. Block and colleagues, which demonstrated that epidural analgesia provides superior pain relief compared to systemic opioids in major surgical procedures, particularly thoracic surgeries [14,15].

The better pain management with TEA was reflected on respiratory outcome improvement in our experiment. The patients who were administered epidural analgesia recorded high oxygen saturation levels, better performance of incentive spirometry and reduced respiration rates that suggest better ventilation. This clinical

relevance of the findings, is that the best respiratory condition is needed to avoid the development of postoperative pulmonary complications. Similar findings were represented by Ballantyne et al. who established that regional analgesia methods, such as TEA, are much better in terms of pulmonary outcomes, when compared to systemic opioid administration.[16]

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Systemic opioid-based pain management, on the other hand, was also found to be effective in the reduction of pain, but with a higher number of adverse effects, such as nausea, vomiting, and respiratory depression. These side effects are well reported in literature and might have a detrimental effect on the recovery of the operation. The respiratory depression is especially hazardous among patients of thoracic surgery because it can further worsen the situation of hypoventilation and predispose patients to pulmonary complications. In their systematic review, Liu and Wu emphasized that opioid-related side effects have the capability to counter the positive analgesia effects through the adverse effect on overall recovery. [17]

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The other significant study finding was a shorter length of stay of the epidural group. Pain management, increased respiration, and reduced complications were possible results that led to early mobilization and a quick rate of recovery. Shortened hospital stays benefit patients and also minimise the costs and use of resources in healthcare. The latter is confirmed by Kehlet and Dahl who promoted multimodal and regional analgesia methods as a component of the enhanced recovery guidelines to optimize the outcomes of the surgical process and decrease the hospital stay.[19]

Although TEA is thought to be the gold standard of analgesia in the postoperative phase of thoracic surgery, it might be restricted in some clinical contexts. Such contraindications as coagulopathy, infection of the place of insertion, or patient refusal should be taken into account. Moreover, the method is very skill-based and thus requires close supervision, which is not easily accessible in every health care center, especially in resource constrained facilities. Systemic opioids are still a viable option even in these cases with identified constraints.

Alternatives which are emerging like paravertebral blocks should also be taken into consideration as they have demonstrated similar analgesic effects with possible fewer side effects. According to Davies et al. paravertebral blockade could provide comparable pain control as TEA at a reduced rate of hypotension, and that customized analgesic methods can be advantageous. Nevertheless, TEA remains highly suggested because of its vast amount of evidence base and uniform results in clinical practices.

The strengths of the study are its prospective randomized design and the involvement of full analgesic efficacy and clinical outcomes of the study. Nonetheless, there are some restrictions that should be admitted. The sample size was quite limited and the study was carried out in one center and this can be a limitation to the external validity of the study. As well, chronic post-thoracotomy pain which is a long-term outcome was not assessed.

To sum up, this research supports the results of the previously stated advantages of thoracic epidural analgesia over systemic opioid-based analgesia in the management of post-operative pain during thoracic surgeries. TEA does not only bring about better analgesia but also improves respiratory performance, decreases complications, and decreases hospitalization. Even though patient selection and monitoring should be performed carefully, TEA is recommended as the preferred analgesic modality when used in appropriate patients undergoing thoracic surgery.

Limitation of Study:

This is a comparative study with limited number of sample size, hence its results cannot be generalized to the population level. To get more better result and better generalization, a study with large sample size and multi center is required.

Conclusion:

This study provides strong evidence supporting the use of thoracic epidural analgesia as the preferred modality for postoperative pain management in thoracic surgeries. It not only offers superior analgesia but also improves respiratory function, reduces complications, and shortens hospital stay, the benefits of TEA clearly outweigh its risks in appropriately selected patients.

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