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Original Research Article

COMPARISON OF MEDIAN AND PARAMEDIAN TECHNIQUE OF THORACIC EPIDURAL ANAESTHESIA IN PATIENTS UNDERGOING LAPAROTOMY UNDER COMBINED GENERAL AND EPIDURAL ANAESTHESIA: A PROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: Thoracic epidural anaesthesia, when combined with general anaesthesia, is widely used for perioperative analgesia in patients undergoing laparotomy. The two commonly employed approaches for epidural space identification are the median and paramedian techniques. Although both techniques are routinely practiced, they differ in anatomical approach, technical ease, and potential complication profile. Comparative data on their performance in the thoracic region, particularly in the context of combined general and epidural anaesthesia, remain limited. The objective is to compare the median and paramedian techniques of thoracic epidural catheter placement in patients undergoing laparotomy with respect to technical success, number of attempts, ease of catheter placement, procedure-related complications, and quality of perioperative analgesia.

Materials and Methods: This prospective observational study included 120 adult patients scheduled for elective laparotomy under combined general and thoracic epidural anaesthesia. Patients underwent thoracic epidural catheter placement using either the median or paramedian approach based on the attending anaesthesiologist's routine practice. Data collected included demographic variables, number of attempts required for successful epidural placement, time taken for the procedure, incidence of complications such as vascular puncture, dural puncture, and paraesthesia, and intraoperative as well as postoperative analgesic efficacy. Postoperative pain scores and requirement of rescue analgesia were recorded to assess the quality of analgesia. The two groups were compared using appropriate statistical tests.

Results: Both techniques were found to be effective for thoracic epidural placement. The paramedian approach was associated with a higher first-attempt success rate and fewer needle redirections, whereas the median approach required fewer anatomical landmarks to be negotiated. Procedure-related complications were infrequent in both groups. Postoperative analgesia, as assessed by pain scores and rescue analgesic requirements, was comparable between the two techniques.

Conclusion: Both median and paramedian approaches for thoracic epidural anaesthesia are safe and effective in patients undergoing laparotomy under combined general and epidural anaesthesia. The paramedian approach may offer technical advantages in terms of ease of placement and first-attempt success, while analgesic outcomes remain comparable between the two techniques.

Keywords: Thoracic epidural anaesthesia, Median approach, Paramedian approach, Laparotomy, Combined general and epidural anaesthesia, Postoperative analgesia.

INTRODUCTION

Effective perioperative pain management is a cornerstone of modern anaesthetic practice, particularly in patients undergoing major abdominal surgery such as laparotomy. Inadequately controlled postoperative pain is associated with increased morbidity, delayed mobilization, prolonged hospital stay, and poorer overall outcomes.[1] Thoracic epidural anaesthesia, when combined with general anaesthesia, is widely regarded as one of the most effective techniques for providing superior intraoperative and postoperative analgesia in upper and lower abdominal surgeries.[2] Its benefits include reduced opioid consumption, improved pulmonary function, attenuation of the surgical stress response, and facilitation of early recovery.[3,4]

The success of thoracic epidural analgesia depends not only on appropriate patient selection and drug regimen but also on the technique used to access the epidural space.[5] The two most commonly employed approaches are the median and the paramedian techniques. In the median approach, the needle is introduced in the midline and advanced through the supraspinous ligament, interspinous ligament, and ligamentum flavum before entering the epidural space.[6] In contrast, the paramedian approach bypasses the supraspinous and interspinous ligaments and reaches the epidural space through a more lateral trajectory, potentially reducing resistance from midline structures.[7]

Anatomical characteristics of the thoracic spine make epidural placement in this region technically more challenging than in the lumbar region. The caudal angulation of thoracic spinous processes, narrower interlaminar spaces, and greater depth of the epidural space contribute to increased technical difficulty and may necessitate multiple attempts or needle redirections.[8,9] These factors can influence the choice of approach and may affect the success rate, procedure time, patient discomfort, and risk of complications such as vascular puncture, dural puncture, or paraesthesia.[10,11]

The paramedian approach has been suggested to offer certain technical advantages in the thoracic region by avoiding densely calcified or closely approximated midline ligaments, particularly in elderly patients or those with limited spinal flexion.[12,13] Conversely, the median approach remains widely practiced due to its familiarity, reliance on easily identifiable midline landmarks, and perceived safety in experienced hands.[14] Despite these theoretical differences, both techniques continue to be used routinely in clinical practice, often based on individual operator preference rather than strong comparative evidence.[15]

Most of the available literature comparing median and paramedian approaches has focused on lumbar epidural or spinal techniques, with relatively fewer studies specifically addressing thoracic epidural placement in the setting of major abdominal surgery.[16,17] Moreover, data comparing these two approaches with respect to technical ease, success rates, complication profile, and quality of analgesia under combined general and epidural anaesthesia remain limited and sometimes conflicting.[18,19]

The present prospective observational study was therefore designed to compare the median and paramedian techniques of thoracic epidural anaesthesia in patients undergoing laparotomy under combined general and epidural anaesthesia. The primary aim was to evaluate technical parameters such as number of attempts, ease of catheter placement, and procedure-related complications, along with clinical outcomes related to perioperative analgesic efficacy.[20] By providing a structured comparison in a real-world clinical setting, this study seeks to contribute evidence to guide technique selection for thoracic epidural placement in major abdominal surgery.

MATERIALS AND METHODS

Study design and setting: This was a prospective observational study conducted in the Department of Anaesthesiology at a tertiary care teaching hospital. The study was designed to compare the median and paramedian techniques of thoracic epidural anaesthesia in patients undergoing laparotomy under combined general and epidural anaesthesia.

Study population: 120 Adult patients scheduled for elective laparotomy under combined general and thoracic epidural anaesthesia were included in the study. Patients of either sex, belonging to the American Society of Anesthesiologists (ASA) physical status I to III, were considered eligible for inclusion.

Inclusion criteria

- Adult patients (≥18 years) undergoing elective laparotomy
- ASA physical status I–III
- Planned combined general and thoracic epidural anaesthesia
- Patients who provided informed written consent

Exclusion criteria

- Patient refusal
- Infection at the site of epidural insertion
- Coagulation abnormalities or patients on anticoagulant therapy
- Severe spinal deformity or previous spine surgery at the intended level
- Known allergy to local anaesthetic drugs
- Pre-existing neurological deficits

Group allocation

Patients were allocated to one of two groups based on the technique used for thoracic epidural catheter placement by the attending anaesthesiologist:

- Group M (Median approach): Epidural space identified using the midline (median) approach
- Group P (Paramedian approach): Epidural space identified using the paramedian approach

As this was an observational study, the choice of technique was based on the routine practice and preference of the anaesthesiologist performing the procedure.

Epidural technique: All patients were shifted to the operating room and standard monitoring was instituted, including electrocardiography, non-invasive blood pressure, and pulse oximetry. With the patient in the sitting position, the thoracic epidural space was identified at the appropriate thoracic interspace using either the median or paramedian approach under strict aseptic precautions.

In both groups, an 18G Tuohy needle was used, and the epidural space was identified using the loss-of-resistance to saline technique. After confirmation of the epidural space, an epidural catheter was threaded 3–5 cm into the epidural space and secured. A test dose was administered to rule out intrathecal or intravascular placement. Following successful catheter placement, general anaesthesia was induced as per institutional protocol.

Intraoperative and postoperative analgesia: All patients received a standardized general anaesthesia technique. Epidural analgesia was provided intraoperatively and continued postoperatively using a standardized local anaesthetic–opioid combination as per departmental protocol. Postoperative pain was assessed using a visual analogue scale (VAS) at predefined intervals. Rescue analgesia was administered if the VAS score exceeded the predefined threshold.

Data collection

The following parameters were recorded:

- Demographic data (age, sex, ASA status)
- Level of epidural insertion
- Number of attempts required for successful epidural placement
- Time taken for epidural placement (from skin puncture to catheter fixation)
- Ease of catheter placement (as judged by the performing anaesthesiologist)
- Procedure-related complications such as vascular puncture, dural puncture, paraesthesia, or failed block
- Intraoperative haemodynamic stability
- Postoperative pain scores (VAS) at specified time intervals
- Requirement of rescue analgesia in the postoperative period

Outcome measures: The primary outcomes were technical success, number of attempts, time taken for epidural placement, and incidence of procedure-related complications. Secondary outcomes included quality of postoperative analgesia as assessed by VAS scores and the requirement of rescue analgesia.

Statistical analysis: Data were entered into a spreadsheet and analyzed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation or median (interquartile range) as appropriate, and categorical variables were expressed as frequencies and percentages. Continuous variables were analysed using the students t test while categorical variables were analysed using Chi square test.

Ethical considerations: The study was conducted after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to inclusion in the study. Patient confidentiality was maintained throughout the study, and all procedures were performed in accordance with ethical standards and institutional guidelines.

RESULTS

A total of 120 patients undergoing elective laparotomy under combined general and thoracic epidural anaesthesia were included in the study, with 60 patients in the Median approach group (Group M) and 60 patients in the Paramedian approach group (Group P). The two groups were comparable with respect to age, sex, and ASA physical status. Technical performance parameters such as number of attempts, time taken for epidural placement, and first-attempt success rate were evaluated. Procedure-related complications including vascular puncture, dural puncture, paraesthesia, and failed block were recorded. Postoperative analgesic efficacy was assessed using VAS scores and the requirement for rescue analgesia. The comparative results of both techniques are presented in the following tables.

Table 1: Demographic characteristics of the study population

Parameter	Group M (Median) (n=60)	Group P (Paramedian) (n=60)	p-value
Age (years, mean ± SD)	52.3 ± 11.4	50.8 ± 12.1	0.48
Male, n (%)	38 (63.3%)	36 (60.0%)	0.71
Female, n (%)	22 (36.7%)	24 (40.0%)	0.71
ASA I, n (%)	18 (30.0%)	20 (33.3%)	0.69
ASA II, n (%)	32 (53.3%)	30 (50.0%)	0.71
ASA III, n (%)	10 (16.7%)	10 (16.7%)	1.00

[Table 1] shows the distribution of age, sex, and ASA physical status in both groups.

Table 2: Level of thoracic epidural insertion

Level	Group M (n=60)	Group P (n=60)	Total (n=120)
T7–T8	18 (30.0%)	16 (26.7%)	34 (28.3%)
T8–T9	26 (43.3%)	28 (46.7%)	54 (45.0%)
T9–T10	16 (26.7%)	16 (26.7%)	32 (26.7%)

[Table 2] shows the distribution of epidural insertion levels in both groups.

Table 3: Number of attempts required for successful epidural placement

Attempts	Group M (n=60)	Group P (n=60)
1 attempt	34 (56.7%)	44 (73.3%)
2 attempts	18 (30.0%)	12 (20.0%)
≥3 attempts	8 (13.3%)	4 (6.7%)

[Table 3] compares the number of attempts needed in both groups.

Table 4: First-attempt success rate

Group	First-attempt success, n (%)	Not successful, n (%)	Total
Group M (Median)	34 (56.7%)	26 (43.3%)	60
Group P (Paramedian)	44 (73.3%)	16 (26.7%)	60

[Table 4] shows the proportion of patients in whom epidural space was identified in the first attempt.

Table 5: Time taken for epidural placement

Parameter	Group M (n=60)	Group P (n=60)	p-value
Time (minutes, mean ± SD)	9.6 ± 3.1	7.8 ± 2.6	0.002

[Table 5] compares the procedure time between the two groups.

Table 6: Ease of catheter placement as assessed by the anaesthesiologist

Ease of placement	Group M (n=60)	Group P (n=60)
Easy	28 (46.7%)	40 (66.7%)
Moderate	22 (36.7%)	16 (26.7%)
Difficult	10 (16.6%)	4 (6.6%)

[Table 6] shows the subjective assessment of ease of catheter placement.

Table 7: Procedure-related complications

Complication	Group M (n=60)	Group P (n=60)
Vascular puncture	6 (10.0%)	3 (5.0%)
Dural puncture	2 (3.3%)	1 (1.7%)
Paraesthesia	5 (8.3%)	3 (5.0%)
Failed epidural	4 (6.7%)	2 (3.3%)
No complication	43 (71.7%)	51 (85.0%)

[Table 7] shows the incidence of complications in both groups.

Table 8: Postoperative pain scores (VAS) at different time intervals

Time interval	Group M (mean ± SD)	Group P (mean ± SD)	p-value
2 hours	3.2 ± 0.9	3.0 ± 0.8	0.18
6 hours	3.6 ± 1.0	3.4 ± 0.9	0.22
12 hours	3.8 ± 1.1	3.6 ± 1.0	0.29
24 hours	3.5 ± 1.0	3.3 ± 0.9	0.25

[Table 8] compares mean VAS scores between the two groups postoperatively.

Table 9: Requirement of rescue analgesia in the first 24 hours

Parameter	Group M (n=60)	Group P (n=60)
Required rescue analgesia	18 (30.0%)	14 (23.3%)
Did not require	42 (70.0%)	46 (76.7%)

[Table 9] shows the proportion of patients requiring rescue analgesia postoperatively.

Table 10: Overall technical success and failure rates

Outcome	Group M (n=60)	Group P (n=60)
Successful epidural	56 (93.3%)	58 (96.7%)
Failed epidural	4 (6.7%)	2 (3.3%)

[Table 10] summarizes the overall success of epidural catheter placement in both groups.

[Table 1] shows that both groups were comparable in terms of age, sex distribution, and ASA physical status, with a mean age of 52.3 ± 11.4 years in Group M and 50.8 ± 12.1 years in Group P, and similar proportions of ASA I–III patients. [Table 2] indicates that the most common level of epidural insertion was T8–T9 in both groups, accounting for 43.3% in Group M and 46.7% in Group P. [Table 3] demonstrates that first-attempt placement was achieved in 34 patients (56.7%) in Group M and 44 patients (73.3%) in Group P, while ≥3 attempts were required in 8 patients (13.3%) and 4 patients (6.7%) respectively. [Table 4] further confirms a higher first-attempt success rate in the paramedian group (73.3%) compared to the median group (56.7%). [Table 5] shows that the mean time taken for epidural placement was significantly shorter in Group P (7.8 ± 2.6 minutes) compared to Group M (9.6 ± 3.1 minutes). [Table 6] indicates that catheter placement was rated as easy in 40 patients (66.7%) in Group P compared to 28 patients (46.7%) in Group M, while difficult placement was more frequent in Group M

(16.6%) than in Group P (6.6%). [Table 7] shows that procedure-related complications were less frequent in Group P, with no complication in 51 patients (85.0%) compared to 43 patients (71.7%) in Group M. [Table 8] demonstrates that postoperative VAS scores at 2, 6, 12, and 24 hours were comparable between the two groups with no clinically significant differences. [Table 9] shows that rescue analgesia was required in 18 patients (30.0%) in Group M and 14 patients (23.3%) in Group P. [Table 10] summarizes that overall technical success was achieved in 56 patients (93.3%) in Group M and 58 patients (96.7%) in Group P, indicating high success rates with both techniques, with a slightly higher success in the paramedian group.

DISCUSSION

The present prospective observational study compared the median and paramedian techniques of thoracic epidural anaesthesia in patients undergoing laparotomy under combined general and epidural anaesthesia, with a focus on technical performance, complication profile, and quality of postoperative analgesia. Thoracic epidural analgesia is well established as an effective modality for perioperative pain control in major abdominal surgery and is associated with improved respiratory function, reduced opioid consumption, and enhanced recovery.[2–4] However, successful utilization of this technique depends greatly on the ease and accuracy of epidural space identification, which in turn is influenced by the chosen approach.[5]

In the present study, the paramedian approach demonstrated a higher first-attempt success rate and required fewer multiple attempts compared to the median approach. This finding is clinically relevant, as multiple attempts are known to increase patient discomfort and the risk of procedure-related complications.[10,11] The technical challenges of thoracic epidural placement, including the acute angulation of spinous processes and narrower interlaminar spaces, have been well described and are considered important contributors to failed or difficult epidural placement using the midline approach.[8,9] By bypassing the supraspinous and interspinous ligaments, the paramedian approach may reduce resistance and facilitate easier access to the epidural space in the thoracic region.[7,12]

The shorter procedure time observed with the paramedian technique in this study further supports its technical advantage in the thoracic region. Reduced procedure time is not only beneficial for operating room efficiency but may also reduce patient anxiety and discomfort during epidural placement. Previous reports have suggested that anatomical constraints in the thoracic spine can prolong the procedure when the median approach is used, particularly in patients with limited spinal flexion or age-related degenerative changes.[12,13] Our findings are consistent with these observations and suggest that the paramedian approach may offer practical benefits in such clinical scenarios.

With regard to complications, both techniques were associated with a low incidence of adverse events, and serious complications such as dural puncture were infrequent. Nevertheless, the median approach showed a slightly higher incidence of vascular puncture, paraesthesia, and failed epidural placement. Procedure-related complications have been shown to correlate with repeated needle passes and difficult anatomy,[10,11] which may partly explain the higher complication rates observed with the median approach in the present study. Although the differences were not large, this trend favors the paramedian approach in terms of procedural safety.

Despite the technical differences between the two approaches, postoperative analgesic outcomes, as assessed by VAS scores and the requirement for rescue analgesia, were comparable between the groups. This finding is not unexpected, as once the epidural catheter is correctly positioned, the quality of analgesia is more dependent on drug regimen and catheter function than on the initial approach used for placement.[3,4] Similar observations have been reported in previous studies comparing different approaches to neuraxial techniques, where technical ease differed but analgesic efficacy remained equivalent.[16,17]

The choice between median and paramedian approaches in routine practice is often influenced by operator training, familiarity, and perceived safety rather than strong comparative evidence.[14,15] While the median approach remains widely practiced due to its reliance on midline landmarks and long-standing teaching, the paramedian approach has been advocated in situations where midline access is difficult or when repeated attempts are anticipated.[12,13] The present study adds to the existing literature by providing focused data on thoracic epidural placement in the context of major abdominal surgery, a setting in which comparative evidence remains relatively limited.[18,19]

The findings of this study suggest that while both approaches are safe and effective, the paramedian technique may offer advantages in terms of first-attempt success, reduced procedure time, and a lower incidence of minor complications. These technical benefits may be particularly relevant in busy operating room settings and in patients with challenging thoracic anatomy. However, it is important to emphasize that both techniques achieved high overall success rates, and the choice of approach should also consider the experience and comfort level of the anaesthesiologist.[5,15]

The present study has certain limitations. As an observational study, allocation to technique was based on operator preference, which may introduce selection bias. In addition, the assessment of ease of placement involved a subjective component. Nevertheless, the study reflects real-world clinical practice and provides pragmatic information relevant to daily anaesthesia practice. Further randomized

controlled trials with larger sample sizes would be useful to confirm these findings and to better define the optimal approach for thoracic epidural placement in different patient populations.[20]

This study demonstrates that both median and paramedian approaches are effective for thoracic epidural anaesthesia in patients undergoing laparotomy, but the paramedian approach appears to offer technical advantages without compromising analgesic efficacy. These results support the consideration of the paramedian technique as a preferred approach in selected patients and clinical settings.

CONCLUSION

This prospective observational study demonstrates that both the median and paramedian approaches for thoracic epidural anaesthesia are safe and effective in patients undergoing laparotomy under combined general and epidural anaesthesia. However, the paramedian approach was associated with a higher first-attempt success rate, fewer multiple attempts, shorter procedure time, and a lower incidence of minor procedure-related complications. Despite these technical differences, postoperative analgesic outcomes, as reflected by pain scores and rescue analgesic requirements, were comparable between the two techniques. These findings suggest that while both approaches can be used successfully in routine clinical practice, the paramedian technique may offer practical advantages, particularly in patients with challenging thoracic anatomy or in settings where procedural efficiency is important.

Limitations: The present study has certain limitations. As a prospective observational study, the choice of technique was based on the individual anaesthesiologist's preference rather than random allocation, which may introduce selection bias. The sample size, although adequate for observing differences in technical performance, may not have been sufficient to detect rare complications. The assessment of ease of catheter placement included a subjective component, which could vary between operators. In addition, the study was conducted at a single center, which may limit the generalizability of the findings. Future randomized controlled trials with larger sample sizes and multicenter participation would help to further validate these results and refine recommendations regarding the optimal approach for thoracic epidural placement.

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