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Original Article

Anaesthesia Section

Continuous Rectus Sheath Block versus Epidural Analgesia for Postoperative Haemodynamic Stability after Elective Midline Laparotomy: A Randomised Controlled Trial

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ABSTRACT

Introduction: Effective postoperative pain management is essential for optimal recovery after elective midline laparotomy. While epidural analgesia is widely used, it may cause sympathetic blockade, leading to hypotension and bradycardia. Continuous Rectus Sheath Block (CRSB) is a potential alternative that provides effective analgesia without compromising haemodynamic stability.

Aim: To compare postoperative haemodynamic stability between CRSB and epidural analgesia in patients undergoing elective midline laparotomy.

Materials and Methods: This single-blinded randomised controlled trial was conducted at the Department of Anaesthesiology, SRM Medical College, Hospital and Research Centre, Tamil Nadu, India, from August 2024 to February 2026. A total of 64 adult patients, American Society of Anaesthesiology Physical Status (ASA I-III), scheduled for elective midline laparotomy, were enrolled and randomly assigned to two groups: Group CRSB (n=32) receiving continuous bilateral RSB and Group Epidural (n=32) receiving standard epidural analgesia. Demographic data, including age, gender, and Body Mass Index (BMI), were recorded at baseline. Postoperative haemodynamic parameters, Mean Arterial Pressure (MAP) and heart rate, were measured at predetermined intervals. Pain was assessed using the Visual Analogue Scale (VAS), and the time to return of bowel sounds was recorded. Statistical analysis was performed using Student's t-test and Chi-square test, with $p<0.05$ considered statistically significant.

Results: Both groups were comparable in baseline demographics (mean age 48.5±10.2 years). The CRSB group experienced faster return of bowel function ($p=0.027$).

Conclusion: The CRSB provides analgesia equivalent to epidural analgesia, with improved haemodynamic stability and accelerated gastrointestinal recovery. It represents a safe and effective alternative, particularly for patients at risk of haemodynamic compromise.

Keywords: Analgesia, Nerve block, Postoperative care

INTRODUCTION

Elective midline laparotomy is commonly performed for a wide range of abdominal conditions, including malignancies and bowel disorders, and is often associated with significant postoperative pain that can adversely affect recovery. Enhanced Recovery After Surgery (ERAS) protocols emphasise effective pain management, as inadequate analgesia is linked to a prolonged stress response characterised by catecholamine surge, impaired respiratory function, delayed mobilisation, reduced gastrointestinal motility, increased thromboembolic risk, and prolonged Intensive Care Unit (ICU) stay [1,2].

Epidural analgesia has long been considered the gold standard for postoperative pain control in abdominal surgery due to its ability to attenuate the surgical stress response and provide superior analgesia [3]. However, its use is associated with adverse effects such as hypotension, bradycardia, urinary retention, and motor blockade, and in rare cases, serious complications like epidural haematoma, particularly in patients with coagulopathy [4]. The sympathetic blockade induced by epidural analgesia may reduce systemic vascular resistance and cardiac output, resulting in haemodynamic instability that may necessitate vasopressor support and increase ICU stay [5].

In recent years, fascial plane blocks have emerged as effective alternatives for postoperative analgesia. The RSB provides somatic analgesia to the anterior abdominal wall by targeting the terminal branches of the lower thoracic intercostal nerves (T6-T11) [6]. Continuous RSB (CRSB), administered via catheter-based infusion of local anaesthetic, offers sustained analgesia without significant sympathetic blockade, thereby preserving haemodynamic stability [7].

A study evaluating abdominal wall fascial plane blocks has demonstrated analgesia comparable to epidural techniques while maintaining superior haemodynamic stability [8]. Haemodynamic stability in the postoperative period is crucial, as fluctuations in blood pressure can compromise organ perfusion and contribute to complications such as acute kidney injury and delayed gastrointestinal recovery [9]. Therefore, the present study aimed to compare postoperative haemodynamic stability between CRSB and epidural analgesia in such patients. The primary objective was to assess postoperative haemodynamic stability, while the secondary objectives were to evaluate postoperative pain and bowel recovery.

MATERIALS AND METHODS

This single-blinded randomised controlled trial was conducted in the Department of Anaesthesiology at SRM Medical College Hospital and Research Centre, Tamil Nadu, India, during a period of 18 months from August 2024 to February 2026 following the approval of the Institutional Ethics Committee (IEC No: EC/NEW/INST/2022/2933). This was conducted in accordance with the Clinical Trials Registry of India (CTRI/2025/01/078977), and the written consent of all participants was obtained. The research was conducted according to the Declaration of Helsinki and Good Clinical Practice standards.

Sample size calculation: Sample size was calculated based on the primary outcome, postoperative MAP. An absolute difference of 5 mmHg between groups was considered clinically meaningful based on anticipated postoperative haemodynamic changes and expert clinical judgment. A standard deviation of 6 mmHg was conservatively assumed for sample size estimation [10]. With a confidence level of 95% and power of 80%, the minimum required sample size was 23 patients per group. To account for possible attrition and enhance study robustness, 32 patients were included in each group.

$$n = \frac{2(Z_{\alpha/2} + Z_{\beta})^2 \sigma^2}{d^2}$$

- $Z_{\alpha/2}$ = 1.96 at 95% confidence interval
- Z_{β} = 0.84 for 80% power
- σ = 6 mmHg (standard deviation)
- d = 5 mmHg (expected mean difference)

$$n = \frac{2(1.96 + 0.84)^2 \times 6^2}{5^2}$$

$$n = \frac{2(2.8)2 \times 36}{25}$$

$$n = \frac{2 \times 7.84 \times 36}{25}$$

$$n = \frac{564.48}{25} = 22.57$$

Thus, the minimum sample size required per group is 23

To compensate for approximately 20-25% attrition and to improve study power, 32 patients were included in each group.

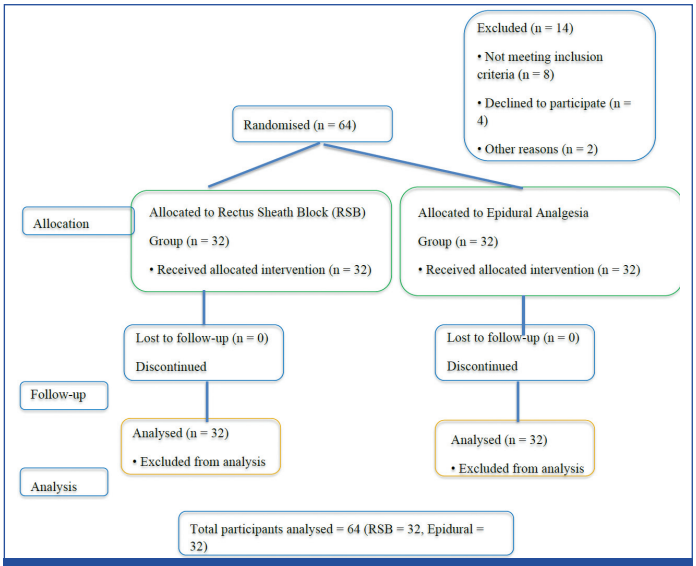
Inclusion criteria: The patients included in the study were those aged 18 years and above, with ASA physical status I-III, who were haemodynamically stable and scheduled for elective midline laparotomy.

Exclusion criteria: The patients excluded from the study were those with abnormalities of the spine or contraindications to epidural analgesia, known allergies to Ropivacaine or opioids, known coagulopathy or bleeding disorders, pregnant patients, patients on mechanical ventilation, ASA PS III patients with an implanted pacemaker or on dialysis and patients who did not give informed consent.

Study Procedure

A total of 78 patients were evaluated for eligibility, with 14 of them excluded, and 64 patients were eligible and randomised to form two groups [Table/Fig-1].

A random number sequence was generated by the computer, and an independent investigator carried out the randomisation. Sealed opaque envelopes were used to conceal allocation. They were randomly chosen as either group R (CRSB) or group E (epidural analgesia). This was a single-blinded randomised controlled trial in which postoperative data collection and outcome assessment were performed by an independent investigator blinded to group allocation. All patients had standardised anaesthetic and postoperative analgesic procedures. Group R received bilateral ultrasound-guided CRSBs, which were done postoperatively with 20 mL of 0.2% ropivacaine with fentanyl (2 µg/mL) on each side. A catheter was inserted, and the continuous infusion was given at 5 mL per hour with a Patient Controlled Analgesia (PCA) pump for 48 hours with a bolus dose of 2 mL and a lockout period of 20 min. In group E, an epidural catheter was placed at the T12 level preoperatively and inserted 5 cm into the epidural space. The analgesia was sustained with 0.2% ropivacaine and fentanyl (2 µg/mL) at the rate of 0.1 mL/kg/hour, and Patient-Controlled Epidural Analgesia (PCEA) with a



[Table/Fig-1]: Consolidated Standards of Reporting Trials (CONSORT) flow diagram.
RSB: Rectus Sheath Block

20-minute lockout period and 2 mL bolus. The catheter remained in situ for 48 hours after the operation. Primary outcomes included postoperative haemodynamic parameters {heart rate, systolic Blood Pressure (BP), diastolic BP and Mean Arterial Pressure (MAP). Secondary outcomes included VAS pain scores and time to return of bowel sounds.

STATISTICAL ANALYSIS

Data were entered into Microsoft Excel and analysed using Statistical Package for Social Sciences (SPSS) version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean±standard deviation and compared using an Independent sample t-test. Categorical variables were analysed using the Chi-square test or Fisher's exact test. A p-value <0.05 was considered statistically significant.

RESULTS

Baseline characteristics: The study included 64 patients equally distributed between the Epidural and CRSB groups (n=32 each). Both groups were comparable in baseline demographics (mean age 48.5±10.2 years) [Table/Fig-2].

Variables	Category	Epidural (n=32)	CRSB (n=32)	Test value	p-value
Age group (years)	30-40	6	4	1.767*	0.622
	41-50	9	6		
	51-60	11	13		
	61-70	6	9		
Gender	Female	14	16	0.251*	0.616
	Male	18	16		
Height (cm)	Mean±SD	164.91±9.08	164.75±8.12	-0.073†	0.942
Weight (kg)	Mean±SD	67.00±10.59	70.47±11.42	1.26†	0.212
BMI (kg/m²)	Mean±SD	24.69±3.85	25.97±3.96	1.306†	0.197
ASA grade	I	4	3	0.61*	0.737
	II	12	15		
	III	16	14		
Type of surgery	Bowel perforation/ obstruction	6	4	0.421*	0.516
	Staging laparotomy	26	28		

[Table/Fig-2]: Baseline demographic and clinical characteristics of the study participants.
* Pearson's Chi-square test

Comparison of MAP between two groups

At every time point that was monitored, the RSB group's MAP was consistently greater than that of the epidural group. MAP was significantly higher in the RSB group at multiple postoperative intervals [Table/Fig-3].

Time point	CRSB (Mean±SD)	Epidural (Mean±SD)	t-value	p-value
2 h	81.2±4.3	72.8±4.5	1.36	0.17
4 h	81.6±4.6	74.1±4.4	1.35	0.018
6 h	83.1±4.4	72.8±4.3	2.12	0.04
8 h	82.5±4.2	71.9±4.1	3.01	0.004
10 h	82.9±4.0	71.5±4.0	3.45	0.001
12 h	83.3±4.8	73.2±4.2	2.98	0.004
14 h	82.7±4.9	73.0±4.1	2.34	0.02
16 h	83.0±4.6	75.4±4.3	3.82	< 0.001
18 h	81.9±4.9	72.8±4.2	1.61	0.11
20 h	81.8±4.3	70.8±4.1	3.08	0.003
POD 1	82.0±4.4	71.6±4.2	3.22	0.002
POD 2	82.1±4.2	72.8±4.3	1.84	0.07

[Table/Fig-3]: Comparison of MAP across two groups at different time points (in hours).
* Independent samples t-test

Comparison of Heart Rate (HR) between study groups

The RSB group demonstrated lower heart rate values at multiple postoperative time points, indicating better haemodynamic stability [Table/Fig-4].

Time point	CRSB (Mean±SD)	Epidural (Mean±SD)	t-value	p-value
2 h	75.6±4.5	77.1±4.6	-1.12	0.27
4 h	76.8±5.5	78.0±4.7	-1.38	0.17
6 h	76.8±4.1	79.1±4.1	-2.21	0.03
8 h	76.1±4.3	80.5±4.9	-3.45	0.001
10 h	77.2±4.8	81.0±4.4	-3.10	0.003
12 h	78.8±4.7	82.2±4.8	-3.12	0.003
14 h	76.5±5.1	79.8±5.0	-2.45	0.026
16 h	77.8±4.9	81.2±5.2	-2.98	0.005
18 h	77.3±4.4	79.6±4.7	-1.65	0.137
20 h	77.7±5.0	81.1±5.2	-2.34	0.024
22 h	78.1±5.0	80.9±4.9	-2.10	0.049
POD 1	77.2±4.8	81.6±5.1	-2.98	0.005
POD 2	77.4±4.4	79.6±4.6	-1.48	0.14

[Table/Fig-4]: Comparison of Heart Rate (HR) between study groups at different time points.

Comparison of VAS pain scores between study groups

The VAS scores were comparable between the RSB and epidural groups at all postoperative time points, with no statistically significant differences observed.

The overall mean VAS scores were also similar, indicating that both techniques provided equivalent postoperative analgesic efficacy [Table/Fig-5].

Time point	CRSB (Mean±SD)	Epidural (Mean±SD)	t-value	p-value
2 h	3.8±0.9	3.9±0.8	-0.52	0.60
4 h	3.6±0.8	3.7±0.9	-0.61	0.54
6 h	3.4±0.9	3.6±0.8	-1.01	0.31
8 h	3.2±0.8	3.4±0.9	-1.28	0.20
10 h	3.1±0.7	3.3±0.8	-1.36	0.18
12 h	3.0±0.8	3.2±0.9	-1.21	0.23
14 h	3.1±0.9	3.3±0.8	-0.98	0.33
16 h	3.0±0.8	3.2±0.9	-1.14	0.26
18 h	3.1±0.8	3.3±0.9	-0.94	0.35
20 h	3.0±0.7	3.2±0.8	-1.09	0.28
22 h	2.9±0.8	3.1±0.9	-1.12	0.27
POD 1	2.8±0.7	3.0±0.8	-1.31	0.19
POD 2	2.7±0.6	2.9±0.7	-1.24	0.22
Overall mean	3.12±0.78	3.31±0.84	-1.28	0.204

[Table/Fig-5]: Comparison of VAS pain scores between study groups.

The CRSB group demonstrated significantly earlier return of bowel sounds compared to the epidural group (p=0.027), indicating faster postoperative gastrointestinal recovery. Fewer patients in the CRSB group experienced delayed bowel recovery beyond 48 hours [Table/Fig-6].

Time to reappearance of bowel sounds	CRSB group (n=32)	Epidural group (n=32)	p-value
≤24 h	24	14	0.027*
24-48 h	6	10	
> 48 h	2	8	

[Table/Fig-6]: Time to re-appearance of bowel sounds between study groups.

DISCUSSION

The present randomised controlled trial compared RSB with epidural analgesia in patients undergoing elective midline laparotomy, with postoperative haemodynamic stability as the primary outcome. Both groups were comparable with respect to baseline demographic and clinical characteristics. The findings demonstrated that patients receiving CRSB maintained significantly higher MAP and lower heart rate at several postoperative time points compared with those receiving epidural analgesia. In addition, postoperative pain scores were comparable between the groups, while return of bowel function occurred significantly earlier in the RSB group. A major finding of the present study was the superior postoperative haemodynamic stability observed in patients receiving continuous RSB. MAP remained significantly higher, and heart rate significantly lower at multiple postoperative intervals in the CRSB group compared with the epidural group. These findings suggest that RSB provides effective analgesia without causing the sympathetic blockade commonly associated with epidural analgesia.

The findings of the present study are consistent with Tudor EC et al., who reported that rectus sheath catheter techniques provided adequate postoperative analgesia while avoiding the hypotension frequently encountered with epidural analgesia [11]. The improved haemodynamic profile observed in the present study may be attributed to the peripheral nature of the block, which provides somatic analgesia without significant effects on sympathetic tone, vascular resistance, or venous return. Maintenance of adequate postoperative blood pressure is clinically important, particularly in elderly patients and those with cardiovascular co-morbidities. Perioperative hypotension has been associated with adverse outcomes, including impaired organ perfusion, acute kidney injury, and delayed postoperative recovery [12]. Therefore, the improved haemodynamic stability observed with continuous RSB may have important clinical implications in high-risk surgical patients.

Another important finding of the present study was that postoperative pain scores were comparable between the two groups at all assessed time points. This suggests that CRSB provides analgesia equivalent to epidural analgesia following elective midline laparotomy. Tudor EC et al., also found equivalent analgesic efficacy between rectus sheath catheters and epidural analgesia in patients undergoing colorectal laparotomy [11].

The comparable analgesic efficacy observed in the present study can be explained by the mechanism of action of the RSB. Midline

laparotomy pain is predominantly somatic in origin and arises from the anterior abdominal wall. By blocking the anterior cutaneous branches of the thoracoabdominal nerves, continuous RSB provides targeted analgesia directly at the site of surgical incision.

The present study demonstrated significantly earlier return of bowel function in patients receiving CRSB. A greater proportion of patients in the RSB group regained bowel sounds within 24 hours, whereas delayed bowel recovery beyond 48 hours was more common among patients receiving epidural analgesia. Early restoration of gastrointestinal function is a key component of ERAS protocols and contributes substantially to patient recovery and shorter hospital stays. The improved bowel recovery observed in the RSB group may be related to preservation of autonomic function and avoidance of the sympathetic blockade associated with epidural analgesia. Improved haemodynamic stability and reduced opioid exposure may also contribute to enhanced gastrointestinal motility. Previous studies evaluating abdominal wall fascial plane blocks have similarly reported improved postoperative recovery profiles and earlier mobilisation [13,14]. Reviews of fascial plane blocks have highlighted their role in promoting opioid-sparing analgesia and enhanced postoperative recovery [9,15].

The findings of the present study suggest that CRSB represents a valuable alternative to epidural analgesia for patients undergoing elective midline laparotomy. In addition to providing effective pain relief, RSB preserves haemodynamic stability, facilitates gastrointestinal recovery, and avoids lower-limb motor blockade. These advantages may be particularly beneficial in elderly patients, those with limited cardiovascular reserve, and patients with contraindications to neuraxial anaesthesia such as coagulopathy.

The increasing adoption of ERAS protocols has emphasised the importance of multimodal analgesia strategies that maximise recovery while minimising complications [9,13,16]. CRSB appears well suited to this approach and may contribute to earlier ambulation, reduced postoperative morbidity, and improved patient outcomes [1,2].

Limitation(s)

The present study has several limitations. First, it was conducted at a single tertiary care centre with a relatively small sample size, which may limit generalisability. Second, opioid consumption, patient satisfaction scores, length of hospital stay, and long-term functional outcomes were not evaluated. Third, the study focused primarily on early postoperative outcomes and did not assess long-term complications. Future multicentre randomised controlled trials with larger sample sizes are required to validate these findings and further establish the role of CRSB in abdominal surgery.

CONCLUSION(S)

The CRSB provided postoperative analgesia comparable to epidural analgesia in patients undergoing elective midline laparotomy. Patients receiving RSB demonstrated better postoperative haemodynamic stability, with higher MAP and lower heart rate at multiple postoperative intervals. Earlier return of bowel function observed in the RSB group suggests improved gastrointestinal recovery and enhanced postoperative rehabilitation. Unlike epidural analgesia, CRSB achieved effective pain control without significant sympathetic blockade or haemodynamic compromise. CRSB appears to be a safe and effective alternative to epidural analgesia, especially in patients at risk of hypotension, cardiovascular instability, or those unsuitable for neuraxial techniques. Incorporation of CRSB into ERAS protocols may improve postoperative outcomes, facilitate early mobilisation, and support faster recovery.

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