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Original Research Article

Ultrasound-Guided Bilateral Rectus Sheath Block versus Conventional Intravenous Analgesia for Postoperative Pain Relief in Laparoscopic Surgeries: A Randomized Prospective Study

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Abstract

Background: Laparoscopic surgery is minimally invasive but not pain-free, and conventional intravenous analgesia (opioids and NSAIDs) is limited by adverse effects. Rectus sheath block (RSB) is an ultrasound-guided regional technique that may provide opioid-sparing analgesia. This study compared the postoperative analgesia provided by bilateral RSB with that of conventional intravenous analgesia in laparoscopic surgeries.

Method: Sixty adults (18-60 years, ASA I-II) scheduled for elective laparoscopic surgery under general anaesthesia were randomized to bilateral ultrasound-guided RSB with 15 mL of 0.25% ropivacaine on each side (Group B, n=30) or conventional intravenous analgesia with diclofenac 75 mg (Group C, n=30). Pain was assessed with the Visual Analogue Scale (VAS) at 0, 2, 4, 8, 12 and 24 hours by a blinded assessor, and intravenous tramadol 1 mg/kg was given as rescue analgesia when VAS exceeded 6. The primary outcome was VAS; secondary outcome was time to first rescue analgesia.

Results: VAS scores were significantly lower in the block group at 0, 2, 4 and 8 hours ($p < 0.05$; 2.87 ± 0.94 vs 4.70 ± 1.09 at 4 hours, $p < 0.001$). At 12 hours VAS was higher in the block group (4.93 ± 1.05 vs 4.30 ± 0.84; $p = 0.012$), and there was no difference at 24 hours ($p = 0.54$). At 4 hours, 40% of control patients required their first rescue analgesia, compared with none in the block group ($p = 0.00012$). Nine block patients (30%) needed no rescue analgesia within 24 hours, compared with none in the control group ($p = 0.0019$).

Conclusion: Bilateral ultrasound-guided RSB provided superior early postoperative analgesia (up to 8 hours) and delayed the need for rescue analgesia compared with conventional intravenous analgesia in laparoscopic surgeries, but its advantage was not maintained beyond 12 hours. RSB is a useful component of multimodal analgesia after laparoscopic surgery.

Keywords: Rectus Sheath Block, Laparoscopic Surgery, Postoperative Analgesia, Ropivacaine, Visual Analogue Scale.

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Introduction

Postoperative pain remains a critical concern even after minimally invasive surgery [1]. As opposed to open surgery, laparoscopic surgery is associated with a shorter hospital stay and less postoperative pain [2] and is an integral part of Enhanced Recovery after Surgery (ERAS) pathways [3], yet it is not pain-free. Somatic pain arises from incision and port-site trauma [1]; nerve injury during port placement may contribute to persistent postsurgical pain [4-6].

Pneumoperitoneum is associated with peritoneal changes that may contribute to postoperative discomfort [7,8]. Visceral pain arises from organ manipulation and related intra-abdominal processes [1]. Referred shoulder-tip pain results from residual CO2 under the diaphragm irritating the phrenic nerve, and its intensity correlates with the volume of residual pneumoperitoneum [9-12]. Longer surgery and patient factors such as anxiety, pre-existing pain and pain threshold also influence pain intensity.

Multimodal analgesia has traditionally combined non-steroidal anti-inflammatory drugs (NSAIDs) with opioids. However, NSAIDs may cause gastrointestinal adverse effects [13], and opioids may cause sedation and respiratory depression [14]. Abdominal wall blocks such as the transversus abdominis plane (TAP) block can reduce

postoperative pain and opioid requirements after laparoscopic surgery [15]. Regional analgesic techniques are also incorporated into procedure-specific ERAS recommendations, including those for colorectal surgery [16]. Ultrasound (USG) guidance gives real-time visualisation of nerves, vessels and fascial planes, improving the accuracy and safety of blocks compared with landmark techniques [17].

The rectus sheath block (RSB) was first described in 1899 to relax the abdominal wall before neuromuscular blockers were available [18] and is now used for postoperative analgesia, including after laparoscopic surgery [19,20]. The rectus sheath is formed by the aponeuroses of the three lateral abdominal muscles and encloses the rectus abdominis. Local anaesthetic injected between the muscle and the posterior sheath blocks the thoracolumbar nerve branches supplying the anterior abdominal wall; ultrasound guidance facilitates accurate placement in this plane [18]. RSB reduces pain scores and opioid consumption [19,21], and one randomized study reported better postoperative pain control with surgical RSB than surgical TAP block in morbidly obese patients undergoing major gynaecological surgery [22]. Rectus sheath catheters have been used as an alternative to thoracic epidural analgesia in selected abdominal surgery patients [23,24], although the available comparative evidence is procedure-specific. Complications are uncommon but can include injection outside the sheath and vascular injury [25]. Because RSB provides somatic analgesia to the periumbilical anterior abdominal wall, it may be useful for laparoscopic procedures involving an umbilical port; however, its coverage is principally somatic and does not replace analgesia for visceral pain.

This study compared the postoperative analgesia provided by ultrasound-guided bilateral RSB with that of conventional intravenous (IV) analgesia in patients undergoing laparoscopic surgery. The primary objective was to compare postoperative pain using the Visual Analogue Scale (VAS). The secondary objective was to compare the time to first rescue analgesia.

Material and Methods

Study design and setting: This prospective, randomized study was conducted over two years at S.S. Institute of Medical Sciences and Research Centre, Davanagere, in adults undergoing elective laparoscopic surgery. The study was approved by the Institutional Ethics Committee before initiation. Written informed consent was obtained from all participants after the objectives and procedures were explained, and patient confidentiality was maintained.

Inclusion criteria:

- Adults aged 18-60 years of either sex
- ASA physical status I or II
- Elective laparoscopic surgery (up to 3 hours) under general anaesthesia

Exclusion criteria:

- Refusal to participate
- ASA physical status III or IV
- Known hypersensitivity to ropivacaine
- Coagulopathy or local infection at the injection site
- Inability to communicate or give a valid pain score

Sample size: The sample size was calculated as $n = 2(Z_\alpha + Z_\beta)^2S^2/d^2$, where $Z_\alpha = 1.96$ (95% confidence), $Z_\beta = 0.842$ (80% power), S is the pooled standard deviation (32.9, from group standard deviations of 33.7 and 32.1) and d = 25.3 is the clinically meaningful difference in pain scores. This gave 27 patients per group, which was rounded up to 30 per group (60 in total) to simplify randomization and allow for dropouts.

Randomization and group allocation: Patients were randomly allocated to two equal groups (n = 30 each) using computer-generated random numbers. Group B (block group) received bilateral USG RSB with 0.25% ropivacaine, and Group C (control group) received conventional IV analgesia without a nerve block (Table 1). Postoperative pain scores were recorded by a blinded assessor.

Table 1: Study groups

Group	Technique	Analgesic regimen
B (n=30)	Bilateral ultrasound-guided RSB	15 mL of 0.25% ropivacaine on each side
C (n=30)	Conventional IV analgesia (no block)	Diclofenac 75 mg IV intraoperatively

Both groups received the same general anaesthetic and the same postoperative rescue analgesia (IV tramadol 1 mg/kg when VAS > 6).

Anaesthesia technique: All patients fasted for 6 hours for solids and 2 hours for clear liquids. Monitoring included 5-lead ECG, pulse oximetry and non-invasive blood pressure. After 3 minutes of preoxygenation with 100% oxygen, patients received IV glycopyrrolate (0.01 mg/kg), midazolam (0.05 mg/kg) and fentanyl (1-2 µg/kg). Anaesthesia was induced with IV propofol (2 mg/kg), and intubation was facilitated with vecuronium (0.1 mg/kg). Anaesthesia was maintained with oxygen and air (50:50) and isoflurane (MAC 0.8-1.0). At the end of surgery, residual neuromuscular blockade was reversed with neostigmine (0.05 mg/kg) and glycopyrrolate (0.01 mg/kg), and ondansetron 4 mg IV was given as PONV prophylaxis.

Block technique: In Group B, bilateral RSB was performed by an experienced anaesthesiologist using a Sonosite SII ultrasound machine with a 12 MHz linear transducer placed transversely above the

umbilicus over the rectus abdominis muscle. A 23G Quincke needle was advanced in-plane to the plane between the rectus abdominis and the posterior rectus sheath. After negative aspiration, correct placement was confirmed by hydrodissection, and 15 mL of 0.25% ropivacaine was injected on each side.

Group C received diclofenac 75 mg IV intraoperatively as standard analgesia.

Postoperative assessment: Patients were monitored for 24 hours. Pain was assessed using the VAS (0 = no pain, 10 = worst imaginable pain) at 0 (arrival in the ward), 2, 4, 8, 12 and 24 hours. In both groups, IV tramadol 1 mg/kg was given as rescue analgesia when the VAS exceeded 6. Data were recorded on a structured proforma.

Outcome measures: The primary outcome was the VAS score at the predefined intervals. Secondary outcomes were the time to first request for rescue analgesia and the incidence of PONV.

Statistical analysis: Data were analysed using SPSS Version 25. Descriptive statistics (mean, standard deviation, percentages) were calculated. VAS scores were compared using the independent t-test for normally distributed data and the Mann-Whitney U test for non-normally distributed data. Categorical variables were compared using the chi-square or Fisher's exact test according to cell frequencies. A p-value < 0.05 was considered statistically significant.

Results

Sixty patients (30 per group) were included. Mean age was 40.6 ± 8.8 years in the block group and 41.7 ± 9.2 years in the control group (p = 0.62). The block group included more males (19 vs 11) than the control group (Table 2).

Table 2: Baseline characteristics of patients

Characteristic	Block (n=30)	Control (n=30)	p-value
Age (years), mean ± SD	40.6 ± 8.8	41.7 ± 9.2	0.62
Male, n (%)	19 (63.3)	11 (36.7)	0.07
Female, n (%)	11 (36.7)	19 (63.3)	0.07

Age compared by independent t-test; sex by Fisher's exact test.

Mean VAS scores were significantly lower in the block group at 0 h (1.53 ± 0.63 vs 3.07 ± 0.83), 2 h (1.93 ± 1.08 vs 3.97 ± 0.96) and 4 h (2.87 ± 0.94 vs 4.70 ± 1.09) (all p < 0.001) and at 8 h (4.17 ± 0.99 vs 4.80 ± 1.24; p = 0.03). At 12 h, VAS was significantly higher in the block group (4.93 ± 1.05 vs 4.30 ± 0.84; p = 0.012). At 24 h there was no significant difference (4.40 ± 1.25 vs 4.57 ± 0.82; p = 0.54) (Table 3, Figure 1).

Table 3: VAS scores at different time intervals

Time (h)	Block group (n=30)	Control group (n=30)	t / Z value	p-value
0	1.53 ± 0.63	3.07 ± 0.83	8.08	< 0.001*
2	1.93 ± 1.08	3.97 ± 0.96	5.55	< 0.001*
4	2.87 ± 0.94	4.70 ± 1.09	6.99	< 0.001*
8	4.17 ± 0.99	4.80 ± 1.24	2.19	0.03*
12	4.93 ± 1.05	4.30 ± 0.84	2.58	0.012*
24	4.40 ± 1.25	4.57 ± 0.82	0.61	0.54 (NS)

Values are mean ± SD. Independent t-test or Mann-Whitney U test was used. * Significant (p < 0.05); NS, not significant.

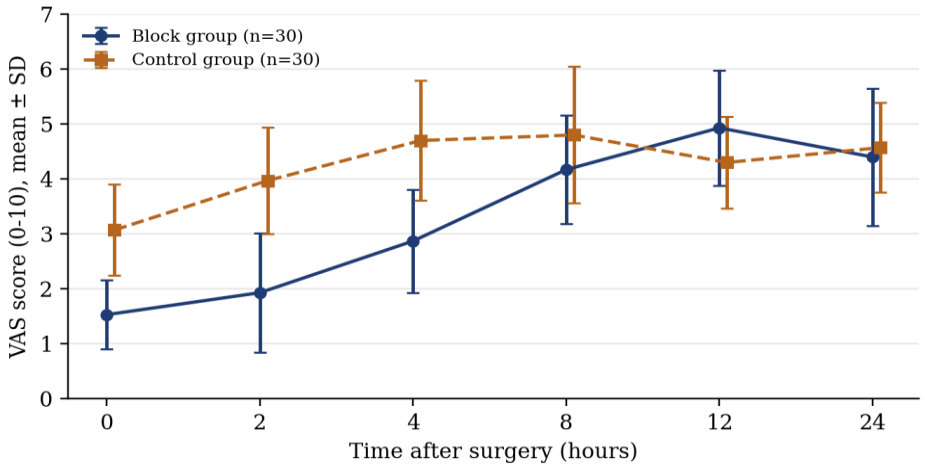


Figure 1: Comparison of postoperative VAS scores (mean ± SD) between the block and control groups over 24 hours

Time to first rescue analgesia differed between the groups (Table 4). No patient in the block group needed rescue analgesia during the first 4 hours, whereas 15 control patients (50%) did: 3 (10%) at 2 hours (p = 0.237) and 12 (40%) at 4 hours (p = 0.00012). At 8 hours, 3 block patients (10%) and 11 control patients (36.7%) required their first rescue dose (p = 0.0303). The difference at 12 hours (p = 0.0716) was not significant. At 24 hours, 7 block patients (23.3%) required their first rescue dose, compared with none in the control group (p = 0.0105). Nine block patients (30%) needed no rescue analgesia within 24 hours, compared with none in the control group (p = 0.0019); all 30 control patients required rescue analgesia, compared with 21 (70%) in the block group.

Table 4: Time to first rescue analgesia

Time of first rescue analgesia (h)	Block group, n (%)	Control group, n (%)	p-value
2	0 (0.0)	3 (10.0)	0.237
4	0 (0.0)	12 (40.0)	0.00012*
8	3 (10.0)	11 (36.7)	0.0303*
12	11 (36.7)	4 (13.3)	0.0716
24	7 (23.3)	0 (0.0)	0.0105*
No rescue within 24 h	9 (30.0)	0 (0.0)	0.0019*
Total	30 (100)	30 (100)	

Fisher's exact test; * significant (p < 0.05).

Discussion

In this randomized study of 60 patients undergoing laparoscopic surgery, bilateral USG RSB gave significantly better early postoperative analgesia than conventional IV analgesia. VAS scores were lower in the block group from arrival in the ward up to 8 hours, and rescue analgesia was delayed: no block patient needed it during the first 4 hours, whereas half of the control patients (15 of 30) did, and 30% of block patients needed none within 24 hours, whereas every control patient required it.

Control group pain rose from about 3 on arrival to 4.7-4.8 by 4-8 hours and remained around 4.3-4.6 up to 24 hours, indicating that the standard regimen did not adequately prevent early moderate pain and supporting the use of multimodal strategies such as regional blocks.

In the block group, pain rose gradually, stayed below 3 at 4 hours and reached about 4 by 8 hours, which delayed the need for rescue analgesia. By 12 hours VAS was higher in the block group than in the control group (4.93 vs 4.30; p = 0.012), most likely reflecting regression of the single-injection block at a time when control scores had already been moderated by earlier rescue analgesia; scores were similar at 24 hours. The benefit of a single-shot block without adjuvants is therefore limited.

The non-significant difference in rescue requirement at 2 hours probably reflects the residual effect of general anaesthesia and intraoperative analgesics. The difference at 12 hours was also not significant, because most control patients had already received rescue analgesia earlier while block regression produced breakthrough pain in the block group; this is consistent with the clustering of first rescue doses in the block group at 12 and 24 hours. The 30% of block patients who needed no rescue analgesia may reflect block efficacy as well as surgical and postoperative factors such as shorter procedures, minimal tissue handling and limited mobilisation. Our findings agree with earlier work. Crosbie et al. [26] reported lower pain scores on waking and lower morphine use with RSB after major gynaecological surgery, and Bakshi et al. [27] found a morphine-sparing effect and earlier mobilisation. Melesse et al. [28] reported lower pain scores, lower analgesic consumption and a markedly longer time to first analgesic request with RSB after emergency midline laparotomy. Meta-analyses of randomized trials support RSB for reducing early pain and opioid consumption, both in laparoscopic surgery [19] and in abdominal surgery generally [29]. Hamid et al. [19] also reported lower rest pain at 10-12 hours, whereas our block group had higher VAS at 12 hours; this may relate to the single-shot, adjuvant-free technique used here and to the earlier rescue analgesia in our control group. RSB is therefore best used as part of a multimodal regimen, and strategies to extend its benefit beyond 8 hours such as longer-acting blocks or adjuncts, merit evaluation.

Conclusion

Bilateral ultrasound-guided RSB provided superior early postoperative analgesia compared with conventional IV analgesia after laparoscopic surgery, with significantly lower VAS scores up to 8 hours and significantly delayed rescue analgesia; 30% of block patients needed no rescue analgesia within 24 hours. The advantage was not sustained, with higher VAS scores in the block group at 12 hours and similar scores at 24 hours. RSB is a valuable component of multimodal analgesia in laparoscopic surgery and may need supplementation to cover the period after block regression.

Future Directions

Studies evaluating adjuvants such as dexmedetomidine or clonidine, or other means of

prolonging block duration, are warranted. Future work should also report static and dynamic pain scores separately and include higher-risk (ASA III and above) patients.

Limitations

The study was conducted at a single centre, which may limit generalisability. Only ASA I-II patients were included, so efficacy and safety in higher-risk patients were not explored. No adjuvants were added to the local anaesthetic, which may have limited the duration of analgesia. Static (rest) and dynamic (movement) VAS scores were not assessed separately, so benefit during coughing or mobilisation may have been underestimated. Postoperative mobilisation could not be standardised and may have influenced pain perception and rescue analgesia. Pain is subjective, and a fixed VAS threshold for rescue analgesia may not reflect each patient's experience. The proportion of males was higher in the block group (63.3% vs 36.7%) despite randomization.

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