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Original Article

Evaluation of the Effectiveness of Ultrasound-Guided Rectus Sheath Blocks in Patients Undergoing Midline Abdominal Surgery

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Abstract

Introduction: Postoperative pain after major abdominal surgery, particularly procedures performed through midline incisions, remains a serious clinical challenge. Despite their effectiveness, conventional analgesic techniques, including patient-controlled analgesia (PCA) and epidural analgesia have notable limitations and complications. The ultrasound-guided rectus sheath block has emerged as a regional analgesic technique that may provide effective anterior abdominal wall analgesia with fewer adverse effects. Thus, this study aimed to evaluate the effectiveness of ultrasound-guided rectus sheath catheter analgesia in reducing postoperative pain following midline abdominal surgery. Secondary outcomes included opioid consumption, early ambulation, return of bowel function, sleep quality, patient satisfaction, and length of hospital stay.

Methods: In this randomized controlled study, 60 patients undergoing elective midline abdominal surgery (ASA II–III) were allocated to block and control groups. All patients received standardized general anesthesia and postoperative PCA. The intervention group also received bilateral ultrasound-guided rectus sheath block with 0.125% bupivacaine. Pain intensity (visual analog scale), PCA usage, opioid consumption, nausea and vomiting, bowel sounds, mobility, sleep quality, and supplemental analgesic requirements were assessed over the first 24 postoperative hours. Ultimately, data were analyzed using appropriate non-parametric statistical tests.

Results: Patients receiving rectus sheath block experienced significantly lower pain scores at all measured time points, reduced PCA activation and opioid consumption, earlier ambulation, earlier return of bowel sounds, improved sleep quality, and reduced need for antiemetics and supplemental morphine compared with the control group.

Conclusion: Overall, ultrasound-guided rectus sheath block provides effective postoperative analgesia after midline abdominal surgery, considerably reduces opioid requirements, and enhances multiple recovery parameters. Despite methodological limitations, these findings support the incorporation of rectus sheath block into multimodal analgesic strategies, with further large-scale studies warranted.

Keywords: Rectus sheath block, Postoperative analgesia, Midline abdominal surgery, Opioid consumption, Ultrasound-guided regional anesthesia

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Introduction

Abdominal surgeries are commonly associated with serious postoperative pain, which can reduce patient satisfaction, delay recovery, and increase postoperative complications. Several methods, such as patient-controlled analgesia (PCA) and epidural catheters, have been widely employed over the past two decades. Evidence indicates that newer techniques, including paravertebral blocks, continuous wound infusion catheters, transversus abdominis plane blocks, and rectus sheath catheters, provide effective postoperative analgesia in abdominal surgeries (1).

Patients undergoing major abdominal procedures typically experience some levels of pain even at rest, which is often manageable with opioids, paracetamol, and nonsteroidal anti-inflammatory drugs. However, movement-related pain (e.g., during coughing) is often more severe, prolonged, and occasionally resistant to conventional analgesics. These surgeries are commonly performed through midline vertical incisions, and effective postoperative analgesia can reduce stress

responses, sympathetic activation, hypercatabolic states, and thrombotic complications. In addition, increased sympathetic tone delays bowel function recovery, resulting in prolonged postoperative ileus (1, 2).

A multimodal analgesic approach, including early ambulation, early feeding, patient education, and combining regional anesthesia with systemic analgesics, provides the greatest benefit. The use of rectus sheath catheters to administer local anesthetics dates back to the 1950s in gynecological surgeries. The technique, which targets the anterior branches of thoracoabdominal intercostal nerves (T6–T11), became easier to perform without ultrasound in the 1990s. The advent of ultrasound guidance significantly improved block accuracy and postoperative analgesic quality (3, 4). Figure 1 displays the anatomical location of the rectus abdominis sheath.

The anterior abdominal wall is innervated by T7–L1 nerves. In addition, intercostal nerves T7–T11 run between the internal oblique and transversus abdominis muscles, piercing the rectus sheath to supply overlying skin. Moreover, T7 innervates the epigastric region, and T10 supplies the periumbilical region. The rectus abdominis muscle, oval in shape, is enclosed by a bilaminar sheath formed by the aponeuroses of the lateral abdominal muscles, forming the anatomical basis for the rectus sheath block (3, 4). Figure 2 illustrates an ultrasound view of the rectus muscle.

Despite the widespread use of PCA and epidural analgesia, both techniques have important limitations, including nausea, vomiting, prolonged ileus, sedation, and, in the case of epidural analgesia, risks such as hypotension, spinal hematoma, infection, and catheter-related failure. Moreover, epidural analgesia is not suitable for all patients, particularly those with infection, coagulopathy, hemodynamic instability, or immunosuppression, and clinical failure rates of up to 30% (3, 6).

These limitations highlight the need for alternative regional analgesic techniques with fewer complications. Ultrasound-guided rectus sheath catheters have emerged as a promising option, offering targeted anterior abdominal wall analgesia while avoiding the systemic side effects of opioids and the risks associated with neuraxial approaches (5).

Despite increasing clinical use, evidence remains limited regarding their effectiveness in major abdominal surgeries performed through midline incisions, particularly with respect to postoperative opioid requirements, early ambulation, duration of ileus, sleep quality, patient satisfaction, and length of hospital stay (5).

Therefore, this study primarily aims to evaluate the effectiveness of ultrasound-guided rectus sheath catheter analgesia in reducing postoperative pain following midline abdominal surgery. Moreover, it seeks to assess postoperative opioid consumption, time to ambulation, incidence of postoperative ileus, patient satisfaction, sleep quality, and hospital length of stay.

Methods

This study was approved by the Research Council of Hamadan University of Medical Sciences and received ethical clearance (IR.UMSHA.REC.1394.158). It was also registered in the Iranian Registry of Clinical Trials (IRCT) website (IRCT2015052615696N2) and funded by Hamadan University of Medical Sciences.

Patients scheduled for elective abdominal surgery with midline incisions who met the inclusion criteria were enrolled after receiving detailed information about the additional pain-control procedure and providing written informed consent.

Additionally, randomization into case and control groups was performed using block randomization. Further, patients were matched based on surgeon and underlying diseases. The inclusion criteria were the American Society of Anesthesiologists (ASA) class II–III, the age range of 18–75 years, elective abdominal surgery with midline incision, and an order for nothing by mouth for more than 8 hours. On the other hand, the exclusion criteria included ASA > III, chronic opioid use, body mass index > 27, allergy to local anesthetics, coagulation disorders, previous hepatic disease, and refusal to participate.

Ultimately, 30 patients were included in each group after applying the exclusion criteria, such as surgery duration > 2.5 hours, intraoperative complications, or intensive care unit transfer. Baseline demographic variables (age and gender) were compared between

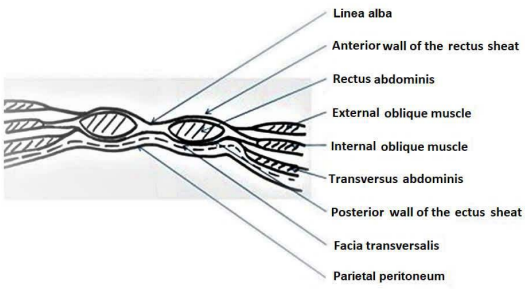

Figure 1. Anatomical Location of the Rectus Abdominis Sheath
Source (4)

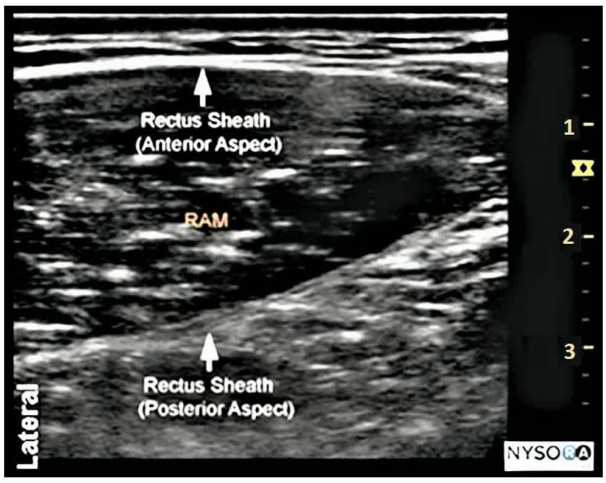

Figure 2. Ultrasound View of the Rectus Muscle
Source (5)

groups, and statistical adjustments were planned for significant differences.

All patients underwent general anesthesia with standard medications: propofol 3–5 mg/kg, fentanyl 3–5 µg/kg, lidocaine 1 mg/kg, midazolam 1–2 mg/kg, and atracurium 0.5 mg/kg. Maintenance anesthesia included isoflurane (1 MAC) and N_2O/O_2 50/50. All patients received an additional 50 µg fentanyl one hour after surgery commencement (7).

In the case group, a bilateral ultrasound-guided rectus sheath block was performed after surgery but before extubation, using 20 cc of 0.125% bupivacaine per side. The block duration was under 7 minutes in all patients and performed solely by the researcher. The procedure was conducted using a Sonosite ultrasound device with a 10 cm VYGON needle under sterile conditions, and all patients received the same concentration and manufacturer of bupivacaine.

Postoperatively, both groups received PCA with 5 mg morphine and 3 g Apotel diluted in 100 cc normal saline. Moreover, patients were monitored in the recovery room for 30 minutes and then transferred to the surgical ward, where monitoring continued by a nurse blinded to group allocation (7). Pain scores (visual analog scale) were recorded at 1 hour, 2 hours, 3 hours, 4 hours, 5 hours, 6 hours, 12 hours, and 24 hours postoperatively. PCA pump activations in hours 1–5 were recorded via patient and companion questioning. In addition, infused pump volume was measured at 6 hours, 12 hours, and 24 hours. Nausea, vomiting, and ondansetron use were documented. Additionally, bowel sounds were assessed hourly, with the first audible bowel sound recorded as before or after 6 hours. Mobility was also evaluated by nursing staff during hours 1–6 and by the researcher at 12 hours and 24 hours. Furthermore, sleep quality on the first postoperative night was recorded and confirmed the next morning. Additional morphine use within 24 hours was documented. The normality of continuous variables was determined using the Kolmogorov-Smirnov test. Non-parametric tests were used since the age variable did not follow a normal distribution ($P<0.05$). Continuous variables were compared using the Mann–Whitney U test, and categorical variables were compared using Chi-square or Fisher's exact test as appropriate. Then, repeated measures of pain scores were analyzed using appropriate non-parametric methods.

Baseline demographic differences (age and gender) were adjusted for in the analysis to control for potential confounding effects. All statistical analyses were performed using SPSS (version 25), with a significance level set at $P<0.05$. The questionnaire used for data collection demonstrated acceptable reliability with a Cronbach's alpha of 0.68.

Results

Demographic characteristics indicated a mean age of 63.5 years and 52.7 years in the block and non-block groups, respectively. In the block group, 64% were male, and 36% were female; in the non-block group, 70% were female, and 30% were male. Substance use history was similar in both groups.

The mean age was 52.07 ± 1.0 years in the block group and 57.63 ± 1.2 years in the control group. Gender and substance use distributions were not significantly different ($P>0.05$).

Based on the results, postoperative pain scores were consistently lower in patients receiving the rectus sheath block. More precisely, these patients required fewer PCA activations and consumed less total analgesic over 24 hours. Pain intensity was lower in the first 6 hours and remained significantly reduced at 12 hours and 24 hours.

Likewise, block patients experienced milder pain at all time points, required fewer PCA boluses, and consumed less analgesic (0–25 mL) compared to controls (50–100 mL). Early mobilization, bowel sounds before 6 hours, and better sleep quality were more frequent in the block group. Ondansetron use and supplemental morphine were minimal or absent in block patients.

Overall, the rectus sheath block significantly improved postoperative pain control, reduced opioid use, and enhanced recovery parameters compared to PCA alone.

Discussion

The mean age of patients (52.07–57.63 years) aligns with those of prior studies in similar populations, including Wilkinson et al, Torii et al, and Cüneyitoğlu et al (8, 9, 10). The findings of pediatric studies, such as Torii et al (9), do not support this finding, reflecting demographic differences. Elective major abdominal surgeries with midline incisions are more common in middle-aged adults. This age distribution is also consistent with the data in our study, confirming the typical demographic pattern of patients undergoing midline abdominal surgery (8, 9, 10).

Pain intensity was consistently lower in the block group during the first 6 hours, which conforms to the results of Bakshi et al, Gupta et al, Elbahrawy and El-Deeb, Jin et al, Kamei et al, Mugita et al, and Kim et al (11, 12, 13, 14, 15, 16, 17). At 12 hours, pain remained lower in the block group, a time point not examined in prior studies. At 24 hours, block patients experienced no to mild pain, whereas most control patients reported moderate pain (Figures 3 and 4), which is in line with the

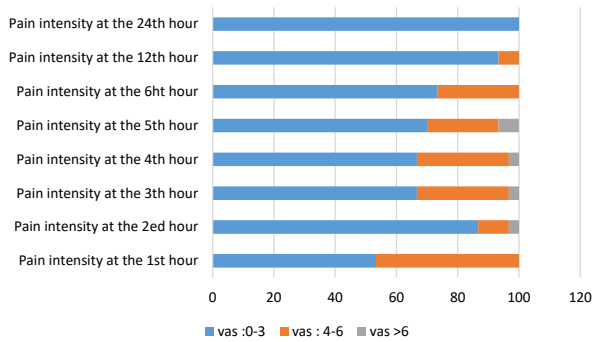

Figure 3. Comparison of Postoperative Pain Intensity Based on VAS in the Rectus Sheath Block Group
Note. VAS: Visual analog scale

results of studies conducted by Gupta et al (12), Kamei et al (15), and Kim et al (17). These findings corroborate our data, with no conflicting evidence reported in earlier literature. However, the underlying mechanism may relate to the prolonged analgesic effect of local anesthetic diffusion within the rectus sheath, which warrants further investigation to clarify pharmacodynamic variability among patients.

PCA pump activations were fewer in the block group, which is consistent with the results of Gupta et al (12). Analgesic consumption via PCA was approximately half at 6 hours, one-third at 12 hours, and one-fourth at 24 hours compared to the control group (Figure 5), which is in conformity with the findings of Bakshi et al (11), Elbahrawy and El-Deeb (13), Kamei et al (15), Kim et al (17), Bashandy and Elkholy (18), Flack et al (19). Our findings strongly support this trend, indicating significantly reduced opioid dependence in patients receiving the block. This opioid-sparing effect is clinically relevant, as it reduces opioid-related side effects while enhancing early recovery (11, 13, 15, 17, 18, 19).

Patient mobilization at 12 hours and 24 hours was faster in the block group (Figure 6), which is consistent with the results of Mugita et al (16). Hemodynamic stability was superior in block patients, with minimal postoperative fluctuations (18) Our study confirm these findings, representing earlier mobilization and more stable heart rate, mean arterial pressure, and respiratory rate among block-treated patients. Improved mobility may also contribute to reduced risk of postoperative complications,

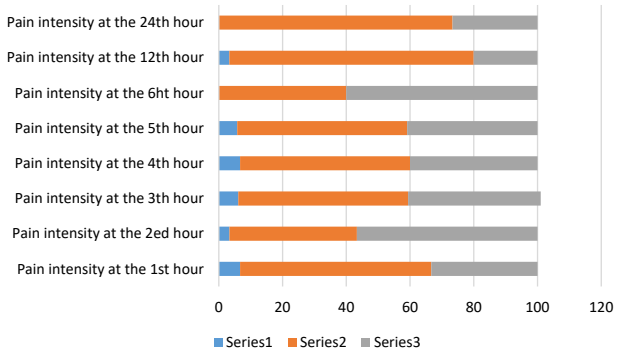

Figure 4. Postoperative Pain Intensity Based on VAS in the Non-Block Group
Note. VAS: Visual analog scale

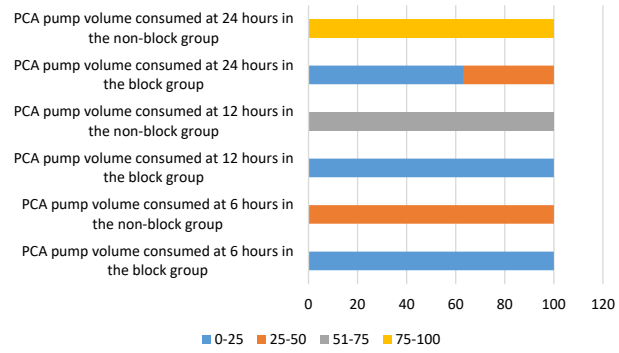

Figure 5. Comparison of Medication Consumption From the PCA Pump Between the Two Groups
Note. PCA: Patient-controlled analgesia

such as atelectasis and thromboembolism (16, 18).

The first bowel sounds (a parameter not previously reported) occurred before 6 hours in most block patients. According to our study, early gastrointestinal recovery appears to be a distinct advantage of the rectus sheath block. Nonetheless, further physiologic studies are required to determine whether this effect is mediated by reduced opioid use or by improved autonomic balance.

Sleep quality was more acceptable in patients, which matches the results of studies by Elbahrawy and El-Deeb and Jin et al (13, 14). Our findings also confirmed improved sleep quality, potentially due to lower nighttime pain and reduced PCA usage.

None of the block patients required supplemental morphine, whereas nearly all control patients needed it, demonstrating previous findings. Ondansetron requirements were lower in the block group, indicating reduced nausea and vomiting. Our study reinforces these findings, suggesting that decreased opioid use directly contributes to reduced postoperative nausea and vomiting (10, 11, 14, 18).

Overall, the ultrasound-guided rectus sheath block is effective for postoperative analgesia, improves mobility, reduces opioid consumption, accelerates gastrointestinal recovery, and enhances sleep quality in patients undergoing midline abdominal surgery. However, the interpretation of these results should be considered in light of certain methodological limitations, including the relatively small sample size, baseline imbalances between groups, and the lack of blinding of the provider administering the block. It noteworthy that these factors may limit generalizability and increase risk of bias; therefore, it is recommended that future researchers perform further multicenter trials with larger cohorts and blinded assessments. Moreover, conflicting evidence was not identified in the literature, which may indicate either true consistency or an underrepresentation of negative or neutral findings (2).

The ultrasound-guided rectus sheath block demonstrated several postoperative benefits in patients undergoing midline abdominal surgery. The technique was associated with reduced pain scores, decreased opioid requirements, earlier return of bowel activity, improved sleep quality, and earlier mobilization. However, given the study's methodological limitations (i.e., a small sample size, potential baseline imbalances, and the lack of

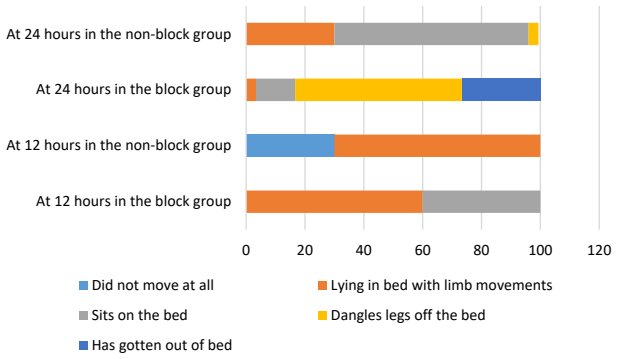

Figure 6. Comparison of Patient Mobility Between the Two Groups

provider blinding) the conclusions should be interpreted cautiously and not overstated.

Clinically, the rectus sheath block may be considered a part of multimodal analgesia to minimize opioid consumption while enhancing early recovery, particularly in major abdominal surgeries. Accordingly, it is suggested that future studies focus on larger populations, older age groups, comparison of single-shot versus catheter techniques, and trials using non-opioid PCA pumps in order to further validate the clinical applicability of these findings.

Authors' Contribution

Conceptualization: Afshin Farhanchi, Farzaneh Kenshlou.
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Formal Analysis: Afshin Farhanchi, Farzaneh Kenshlou, Mahshid Nikooseresht, Mohammad Ali Seif Rabiei.
Investigation: Farzaneh Kenshlou.
Methodology: Afshin Farhanchi, Farzaneh Kenshlou, Mahshid Nikooseresht.
Project Administration: Afshin Farhanchi.
Software: Afshin Farhanchi, Farzaneh Kenshlou, Mahshid Nikooseresht, Mohammad Ali Seif Rabiei.
Supervision: Afshin Farhanchi.
Writing–Original Draft: Farzaneh Kenshlou.
Writing–Review & Editing: Afshin Farhanchi.

Competing Interests

The authors declare that there are no competing interests in this study. The authors had no financial or non-financial relationships with the manufacturers or suppliers of the instruments or drugs used in the study.

Ethical Approval

This study was approved by the Research Council of Hamadan University of Medical Sciences and received ethical clearance (IR.UMSHA.REC.1394.158). In addition, the study was registered in the IRCT system (IRCT2015052615696N2) and funded by Hamadan University of Medical Sciences.

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