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A Comparative Study of Preoperative Versus Post-Operative Ultrasound Guided Bilateral Rectus Sheath Block for Acute Pain Relief in Patient Undergoing Elective Laparoscopic Cholecystectomy By Using Ropivacaine and Dexmedetomidine as an Adjuvant

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ABSTRACT

Background and Objectives: Effective postoperative pain management is essential for improved recovery, reduced morbidity, and enhanced patient satisfaction following abdominal surgeries. Laparoscopic cholecystectomy, though minimally invasive, is associated with significant postoperative pain particularly within the first 24 hours. Regional anaesthetic techniques such as the ultrasound-guided bilateral rectus sheath block have gained popularity as part of multimodal analgesia strategies due to their ability to provide effective somatic pain relief while reducing opioid consumption. Ropivacaine, a long-acting local anaesthetic, is widely used in bilateral rectus sheath block due to its favourable safety profile and effective sensory blockade. However, its duration of analgesia is limited when used alone. Dexmedetomidine, an alpha-2 adrenergic agonist, has been increasingly used as an adjuvant to prolong analgesia and improve block quality. This study aims to compare the effectiveness of postoperative analgesia using ropivacaine alone versus ropivacaine combined with dexmedetomidine in ultrasound-guided bilateral rectus sheath block in patients undergoing elective laparoscopic cholecystectomy. The study focuses on duration of analgesia, haemodynamic parameters, sedation levels, and total postoperative analgesic requirement.

Methods: Following approval from the Institutional Ethics Committee and obtaining informed written consent, a total of 60 patients classified as American Society of Anesthesiologists (ASA) Class I and Il, aged between 18 and 60 years, undergoing elective laparoscopic cholecystectomy under general anaesthesia were enrolled in this prospective, randomized, double-blinded comparative study. Patients were randomly allocated into two groups of 30 each. Group RN received ultrasound-guided bilateral rectus sheath block with 30 ml of 0.2% ropivacaine with normal saline, while Group RD received 30 mL of 0.2% ropivacaine combined with dexmedetomidine (50 ug). The primary outcome measured was the duration of postoperative analgesia, defined as the time from bilateral rectus sheath block administration to the first request for rescue analgesia. Secondary outcomes included total postoperative analgesic consumption within 24 hours, haemodynamic parameters (heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure), sedation levels using the Ramsay Sedation Scale, and pain intensity using the Visual Analogue Scale (VAS) at specified intervals.

Results: The demographic characteristics of patients in both groups were comparable, with no significant differences. The duration of postoperative analgesia was significantly prolonged in Group RD compared to Group RN. Patients in the dexmedetomidine group demonstrated reduced postoperative

analgesic requirements within the first 24 hours. Pain scores assessed using VAS were consistently lower in Group RD at various time intervals. Haemodynamic parameters such as heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure were comparable between the groups at baseline. However, Group RD showed better haemodynamic stability in the postoperative period, with no clinically significant adverse effects. Sedation scores were slightly higher in the dexmedetomidine group, indicating mild and desirable sedation without respiratory depression.

Conclusion: The addition of dexmedetomidine as an adjuvant to ropivacaine in ultrasound-guided bilateral rectus sheath block significantly prolongs the duration of postoperative analgesia, reduces analgesic consumption, and provides better haemodynamic stability compared to ropivacaine alone, Thus, dexmedetomidine serves as an effective and safe adjuvant in bilateral rectus sheath block for patients undergoing elective laparoscopic cholecystectomy.

Keywords*: Laparoscopic Cholecystectomy,Ropivacaine,Dexmedetomidine.*

INTRODUCTION

Cholecystectomy is among the most frequently performed elective surgical interventions, with laparoscopic cholecystectomy (LC) now established as the preferred approach for the treatment of most benign gallbladder disorders[1]. In comparison to open cholecystectomy, LC is regarded as a minimally invasive technique associated with reduced postoperative pain[2]. Nevertheless, patients often experience moderate to severe pain during the immediate postoperative period following LC [3,4], which is frequently undertreated, leading to patient discomfort and delayed recovery[4,5].

Postoperative pain following LC is multifactorial in origin, encompassing incisional, visceral, and referred shoulder pain. The intensity of pain is typically greatest on the day of surgery, with incisional pain being more prominent than visceral pain[4,6]. To address this, various multimodal analgesic strategies have been explored for pain management in patients undergoing LC[7,9]. Recommended interventions include the administration of nonsteroidal anti-inflammatory drugs (NSAIDs), cyclooxygenase-2 (COX-2) inhibitors, dexamethasone, and local anesthetic infiltration (LAI) at the port sites [8,9]. Additionally, abdominal truncal blocks have been advocated as part of multimodal analgesia protocols in laparoscopic abdominal procedures[10,11]. However, the efficacy of the transversus abdominis plane (TAP) block in LC remains controversial [9,12]. Although limited data are available regarding the use of rectus sheath block (RSB) in LC, existing evidence supporting its analgesic efficacy in laparoscopic and umbilical surgeries[9,12] suggests that RSB may offer effective pain relief in the context of LC.

Preemptive analgesia refers to the administration of antinociceptive interventions prior to surgical insult, with the goal of preventing the development of central sensitization caused by incisional and inflammatory injuries, thereby mitigating postoperative pain amplification[18,19]. Adequate suppression of perioperative nociceptive input may reduce the risk of pathological hypersensitivity and improve postoperative analgesic outcomes [18,19]. Although preemptive analgesia has been evaluated across various surgical settings, the findings from experimental studies remain inconsistent and, at times, inconclusive[18,20,21].

In the present study, we hypothesized that administering RSB preoperatively (pre-RSB) could more effectively attenuate intraoperative and early postoperative nociceptive input, thereby better preventing central sensitization and the development of pathological pain compared to postoperative RSB (post-RSB). Accordingly, the objective of this study was to evaluate the analgesic efficacy of pre-RSB in patients undergoing LC.

NEED FOR THE STUDY:

This study is an attempt to compare the total consumption of analgesic in intraoperative and postoperative analgesic, intraoperative hemodynamics, duration of post-operative analgesia using 0.2% Ropivacaine with Dexmedetomidine 50mcg as an adjuvant in Preoperative versus Postoperative ultrasound guided Rectus sheath block for Elective Laparoscopic Cholecystectomy.

AIMS AND OBJECTIVES OF THE STUDY:

Primary objectives:

1.To study Total analgesics consumption in Preoperative versus Postoperative RSB Group

Secondary objectives:

2.The need of rescue analgesic. To evaluate Ramsay sedation score in post-operative period.

MATERIALS AND METHODOLOGY:

Materials

Source of data collection: Patients undergoing elective laparoscopic cholecystectomy at major operation theatre, Hassan Institute of Medical Sciences, Hassan. In a randomized, double-blinded, controlled manner.

Estimation of sample size:

Based on the study by Hye Won Jeong et al[4] based on total rescue analgesic consumption during 24 hours after surgery in pre- RSB and post- RSB group.

The formula used to obtain the sample size was $n = Sd^2 \times (Z_\beta + Z_\alpha)^2 / d^2$

n - Minimum sample size

Z_β - 0.84, Z_α – 1.96

S – Standard deviation – 0.768

d – Mean difference between cases and controls

Sample size arrived will be 26 in each group.

For this study, 30 per group will be used as sample size.

Inclusion criteria:

- Aged 18-60 years
- ASA I and II
- Patients posted for elective laparoscopic cholecystectomies

Willing for informed and written consent

Exclusion criteria:

- Aged <18years and >60years
- Allergy to local anesthetics
- ASA III and IV
- Patients not willing for consent

METHODOLOGY:

Study type: Prospective, randomized and single blinded study

Study place: Study conducted at major operation theatres, Hassan Institute of Medical Sciences, Hassan during September 2023 to September 2024

Study Outcome: Intraoperative analgesic requirement, Intraoperative hemodynamics, Duration of postoperative analgesia.

Study duration: 1 year

After approval from institutional ethical committee, written informed consent obtained from the patients undergoing elective laproscopic cholecystectomy. xx patients were randomly allocated using computer generated randomization sheet into two groups that is Group A (pre-RSB) and Group B (post-RSB) were performed after skin closure and before emergence form anaesthesia. A first investigator enrolling and assessing participants in opaque, sealed and sequentially numbered envelopes, which were given to intervention staff who conducted anaesthesia and ultrasound guided RSB. A second investigator, who blinded to treatment allocation, administered analgesics At the post anaesthesia care unit and general ward during 24h after surgery and assessed postoperative outcome. It was kept blinded to second investigator and participants.

Patients were preoperatively assessed and the procedure explained in detail in their own understandable language. All the patients were premedicated with Tablet. Alprazolam 0.25mg and Tablet. Ranitidine 150mg on the night prior to surgery.
On arrival to operation theatre, baseline heart rate, blood pressure, respiratory rate, peripheral oxygen saturation recorded. An 18G intravenous cannula w inserted in the forearm/dorsum of hand and intravenous infusion of ringer lactate is started. Patients were preoxygenated for 5 minutes, premedicated with Glycopyrrolate 0.01mg/kg, Midazolam 0.03mg/kg and Fentanyl 2mcg/kg. Induction was done with Propofol 2mg/kg and Vecuronium 0.1mg/kg as loading dose of muscle relaxant.

Under USG guidance, Bilateral rectus sheath block performed.

Group A(pre RSB) – received 30ml of 0.2% ropivacaine with 50mcg(0.5 ml) of dexmedetomidine after induction .
Group B(post RSB) – received 30ml of 0.2% ropivacaine with 50mcg(0.5 ml) of dexmedetomidine were performed after skin closure and before emergence form anaesthesia.

Both the patient and the investigator were blinded for the study and Ultrasound (US)-guided Bilateral rectus sheath block

performed after skin closure and before emergence from anesthesia. Under aseptic conditions using a 38 mm, 6–13 MHz linear array US transducer.

For the RSB, the ultrasound probe was positioned transversely on the rectus abdominis muscle, the umbilicus. Guided by real-time ultrasound, a 23-gauge Quincke needle was inserted in-plane with caution to avoid injury to nearby vessels from medial to lateral direction, until its tip positioned in the plane between the lateral side of rectus abdominis muscle and the posterior rectus sheath. After negative pressure aspiration, 15 mL of 0.25% ropivacaine was administered, and then the block was repeated on the opposite side.

Duration of analgesia was measured till the patient has VAS score >3 and asks for rescue analgesia (Inj. Tramadol 50mg IV slow).

VAS score: 0-10 score 0-No pain
1, 2-Mild pain
3, 4, 5-Moderate pain
6, 7-Severe pain
8, 9-Very severe pain 10-Worst possible pain
Side effects such as hypotension (20% decrease in relation to the baseline value), bradycardia (HR), sedation (Ramsay sedation score), nausea and vomiting was noted in both the groups.

STATISTICAL ANALYSIS
Data entered in microsoft excel and SPSS software will be used for the analysis. Categorical data expressed in percentages and proportions. Chi Square test was the test of significance.

Continuous data were represented as mean and standard deviation. Unpaired t test used as the test of significance to identify the mean difference between the two groups.

Observations so made, were put to stastical evaluation and P value <0.05 was taken as significant.

RESULTS

Table 1: Demographic Characteristics of Study Population

Variable	Group RN (n=30)	Group RD (n=30)	t-value	p-value
Age (years)	40.33 ± 8.14	41.03 ± 8.42	0.327	0.745
Weight (kg)	64.72 ± 9.90	66.26 ± 8.28	0.652	0.517
Height (cm)	161.84 ± 7.14	163.02 ± 9.30	0.551	0.584
BMI (kg/m²)	24.79 ± 3.92	25.25 ± 4.78	0.408	0.685
Surgery Duration (min)	56.83 ± 10.27	56.07 ± 8.71	0.312	0.756

Table 1 illustrates the demographic characteristics of the study population comparing Group RN (Ropivacaine + Normal Saline) and Group RD (Ropivacaine + Dexmedetomidine). All baseline parameters including age, weight, height, BMI, and surgery duration were comparable between the two groups with no statistically significant differences (p>0.05), confirming successful randomization and group homogeneity.

Figure 1: Comparison of Demographic Parameters Between Study Groups

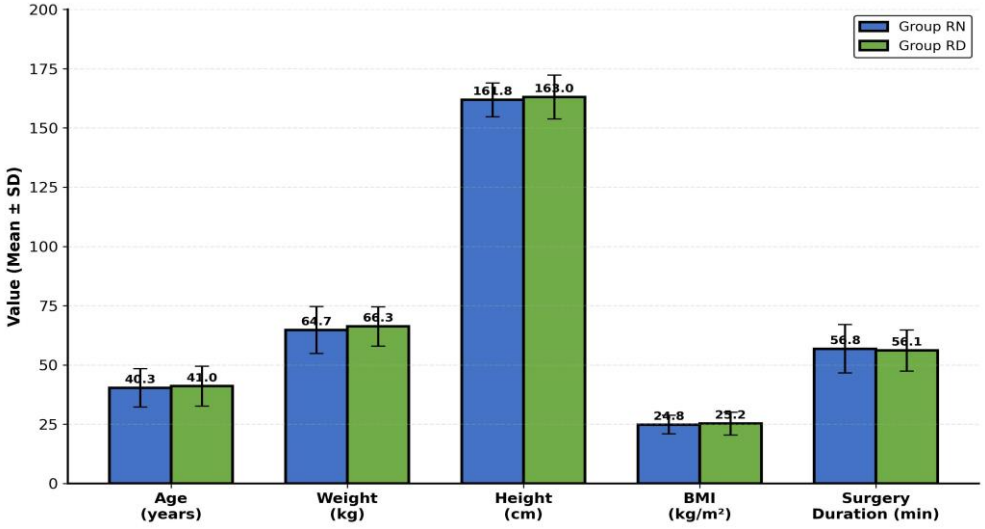


Table 2: Gender Distribution

Gender	Group RN (n=30)	Group RD (n=30)	χ^2 value	p-value
Male	14 (46.67%)	10 (33.33%)	0.625	0.429
Female	16 (53.33%)	20 (66.67%)		
Chi-square test (Yates corrected)			0.625	0.429

Table 2 shows the gender distribution between the two study groups. In Group RN, 14 patients (46.67%) were male and 16 patients (53.33%) were female, while in Group RD, 10 patients (33.33%) were male and 20 patients (66.67%) were female. The chi-square analysis revealed no statistically significant difference in gender distribution between the groups (χ^2=0.625, p=0.429).

Figure 2: Gender Distribution in Study Groups

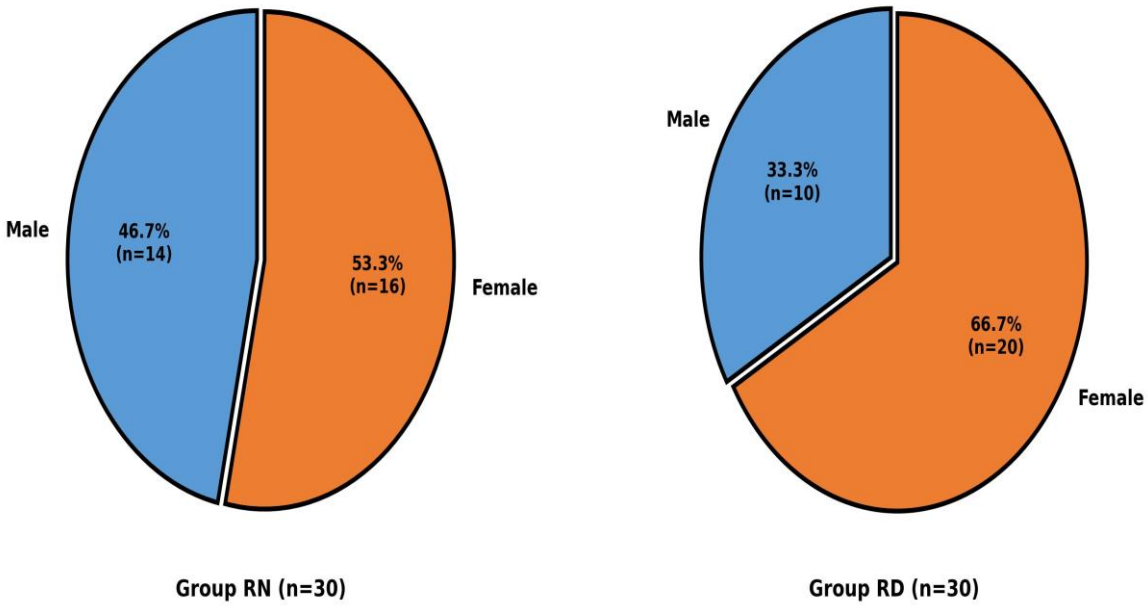


Table 3: ASA Physical Status Distribution

ASA Status	Group RN (n=30)	Group RD (n=30)	χ^2 value	p-value
ASA I	16 (53.33%)	19 (63.33%)	0.274	0.600
ASA II	14 (46.67%)	11 (36.67%)		
Chi-square test (Yates corrected)			0.274	0.600

Table 3 describes the ASA physical status classification of patients in both groups. Group RN comprised 16 patients (53.33%) with ASA I and 14 patients (46.67%) with ASA II status, while Group RD had 19 patients (63.33%) with ASA I and 11 patients (36.67%) with ASA II status. Statistical analysis showed no significant difference between the groups (χ^2=0.274, p=0.600).

Figure 3: ASA Physical Status Distribution

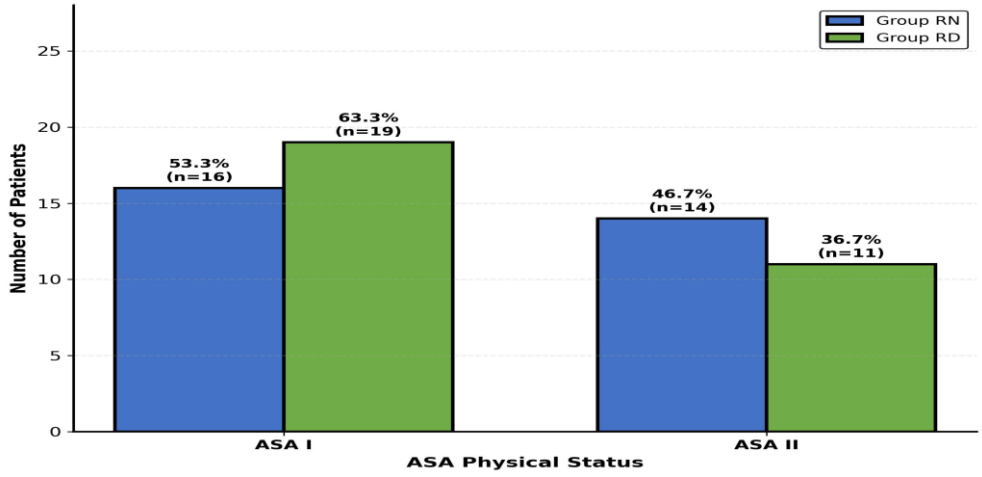


Table 4: Duration of Analgesia (Primary Outcome)

Parameter	Group RN (n=30)	Group RD (n=30)	t-value	p-value
Duration of Analgesia (hours)	6.72 ± 0.86	11.21 ± 1.74	12.679	<0.001

Table 4 presents the primary outcome of the study - duration of analgesia. The mean duration of analgesia was significantly prolonged in Group RD (11.21 ± 1.74 hours) compared to Group RN (6.72 ± 0.86 hours), representing an increase of 4.49 hours (66.8% prolongation). This difference was highly statistically significant (t=12.679, p<0.001), demonstrating the efficacy of dexmedetomidine as an adjuvant.

Figure 4: Comparison of Duration of Analgesia Between Groups

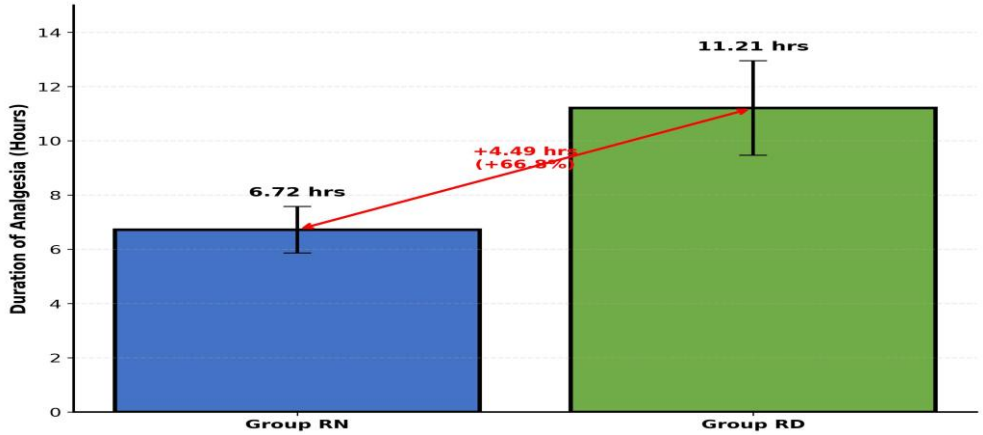


Table 5: Visual Analogue Scale (VAS) Scores at Different Time Points

Time Point	Group RN (n=30)	Group RD (n=30)	t-value	p-value
1 hour	1.27 ± 0.52	0.86 ± 0.39	3.511	<0.001
2 hours	1.83 ± 0.71	1.27 ± 0.45	3.664	<0.001
3 hours	1.94 ± 0.68	1.51 ± 0.51	2.793	0.007
4 hours	2.90 ± 0.76	1.84 ± 0.65	5.766	<0.001
5 hours	3.25 ± 0.92	2.09 ± 0.58	5.827	<0.001
6 hours	3.76 ± 0.87	2.32 ± 0.74	6.917	<0.001
8 hours	4.40 ± 0.88	2.78 ± 0.60	8.297	<0.001
12 hours	3.61 ± 0.82	2.99 ± 0.69	3.165	0.003
16 hours	3.39 ± 0.62	2.58 ± 0.55	5.299	<0.001
20 hours	2.63 ± 0.57	2.11 ± 0.50	3.761	<0.001
24 hours	2.41 ± 0.43	1.97 ± 0.47	3.786	<0.001

Table 5 demonstrates the comparison of VAS scores between the two groups at all measured time points over 24 hours post-operatively. VAS scores were consistently and significantly lower in Group RD compared to Group RN at all time points (p<0.05). The maximum difference was observed at 8 hours post-operatively (4.40 vs 2.78), indicating superior pain control with dexmedetomidine adjuvant throughout the observation period.

Figure 5: VAS Score Trends Over 24 Hours Post-operatively

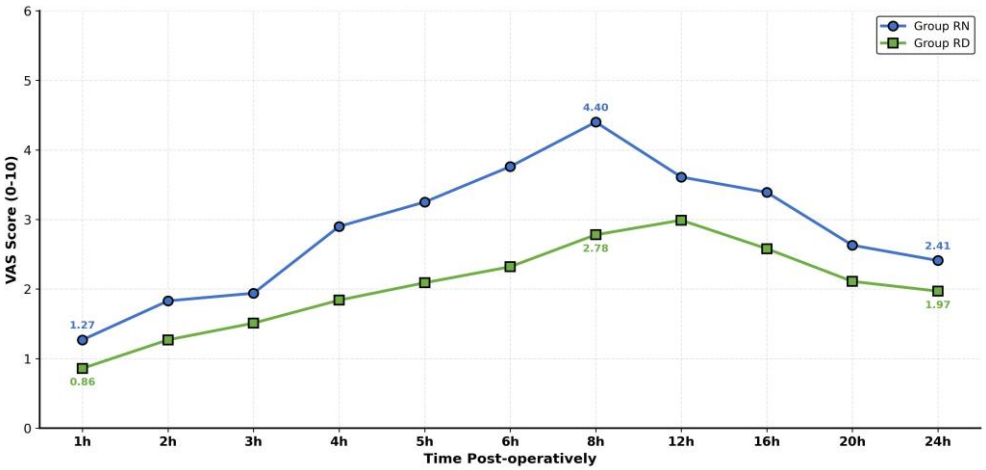


Table 6: Heart Rate (bpm) at Different Time Points

Time Point	Group RN (n=30)	Group RD (n=30)	t-value	p-value
Baseline	77.53 ± 10.53	78.17 ± 9.72	0.242	0.810
1 hour	77.77 ± 8.37	73.87 ± 10.69	1.574	0.121
6 hours	73.40 ± 7.18	74.17 ± 8.79	0.370	0.713
12 hours	71.10 ± 7.03	71.87 ± 7.15	0.419	0.677
24 hours	73.33 ± 6.30	70.43 ± 8.72	1.476	0.146

Table 6 shows the heart rate measurements at baseline and various post-operative time points. There were no statistically significant differences in heart rate between Group RN and Group RD at any measured time point (all p>0.05). Both groups maintained stable heart rates within normal physiological limits throughout the 24-hour observation period, indicating hemodynamic stability with both treatment regimens.

Figure 6: Heart Rate Trends Over 24 Hours

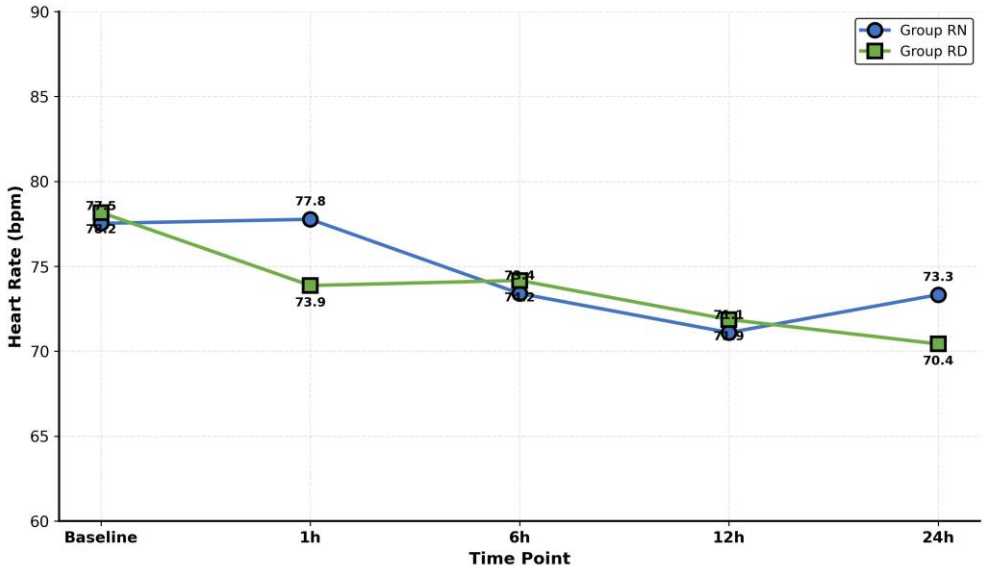


Table 7: Systolic Blood Pressure (mmHg) at Different Time Points

Time Point	Group RN (n=30)	Group RD (n=30)	t-value	p-value
Baseline	126.00 ± 12.17	125.07 ± 10.80	0.314	0.754
1 hour	121.23 ± 9.22	119.70 ± 9.69	0.628	0.532
6 hours	121.77 ± 11.08	114.50 ± 10.48	2.609	0.012
12 hours	117.10 ± 8.54	113.03 ± 9.88	1.706	0.094
24 hours	119.67 ± 9.56	118.27 ± 8.37	0.603	0.549

Table 7 illustrates the systolic blood pressure measurements at various time points. A statistically significant difference was observed at 6 hours post-operatively (p=0.012), with Group RD showing lower values. However, all measurements remained within normal clinical range in both groups. At baseline, 1 hour, 12 hours, and 24 hours, no significant differences were observed between the groups.

Figure 7: Systolic Blood Pressure Trends Over 24 Hours

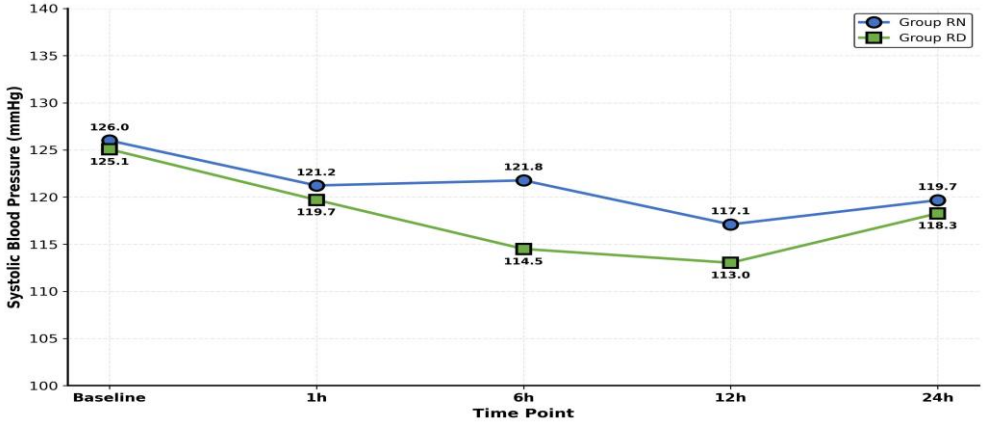


Table 8: Diastolic Blood Pressure (mmHg) at Different Time Points

Time Point	Group RN (n=30)	Group RD (n=30)	t-value	p-value
Baseline	78.57 ± 7.16	77.10 ± 6.26	0.845	0.402
1 hour	77.53 ± 5.88	74.27 ± 7.96	1.808	0.076
6 hours	72.10 ± 7.10	71.53 ± 4.70	0.365	0.717
12 hours	73.37 ± 6.29	70.93 ± 5.03	1.654	0.104
24 hours	73.63 ± 7.22	72.97 ± 6.96	0.364	0.717

Table 8 presents the diastolic blood pressure measurements at different time points. There were no statistically significant differences in diastolic blood pressure between the two groups at any measured time point (all p>0.05). Both groups maintained stable diastolic blood pressure within physiological limits, confirming the hemodynamic safety profile of both treatment approaches.

Figure 8: Diastolic Blood Pressure Trends Over 24 Hours

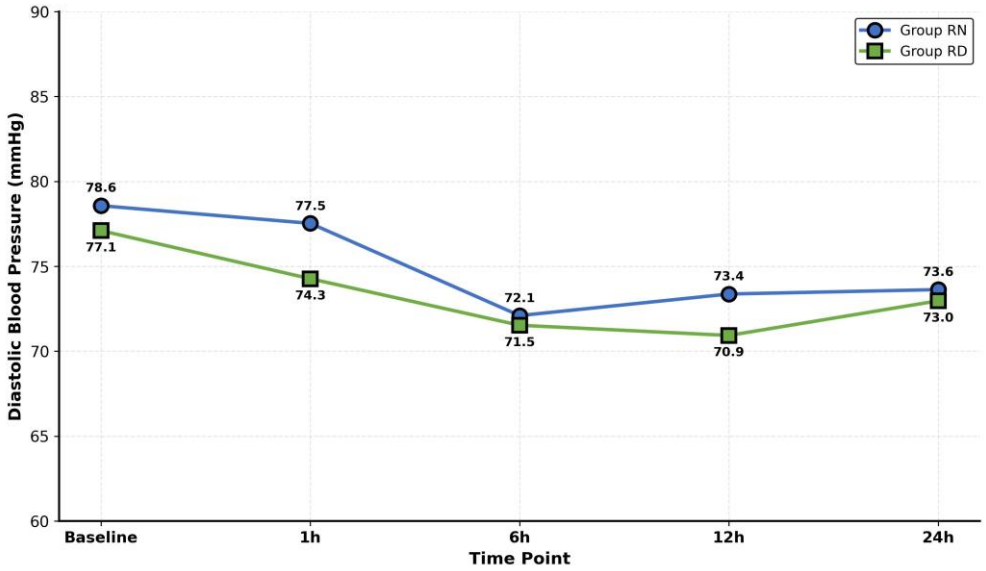


Table 9: Ramsay Sedation Score at Different Time Points

Time Point	Group RN (n=30)	Group RD (n=30)	t-value	p-value
1 hour	2.13 ± 0.35	2.40 ± 0.50	2.408	0.020
6 hours	2.00 ± 0.00	2.30 ± 0.47	3.525	0.001
12 hours	2.00 ± 0.00	2.03 ± 0.18	1.000	0.326
24 hours	2.00 ± 0.00	2.00 ± 0.00	-	-

Table 9 describes the Ramsay Sedation Scores at various post-operative time points. Group RD showed slightly higher sedation scores at 1 hour (p=0.020) and 6 hours (p=0.001) compared to Group RN. However, all scores remained within the acceptable range of 2-3 (calm and cooperative), indicating clinically appropriate sedation levels. By 12 and 24 hours, sedation levels were comparable between groups.

Figure 9: Ramsay Sedation Scores at Different Time Points

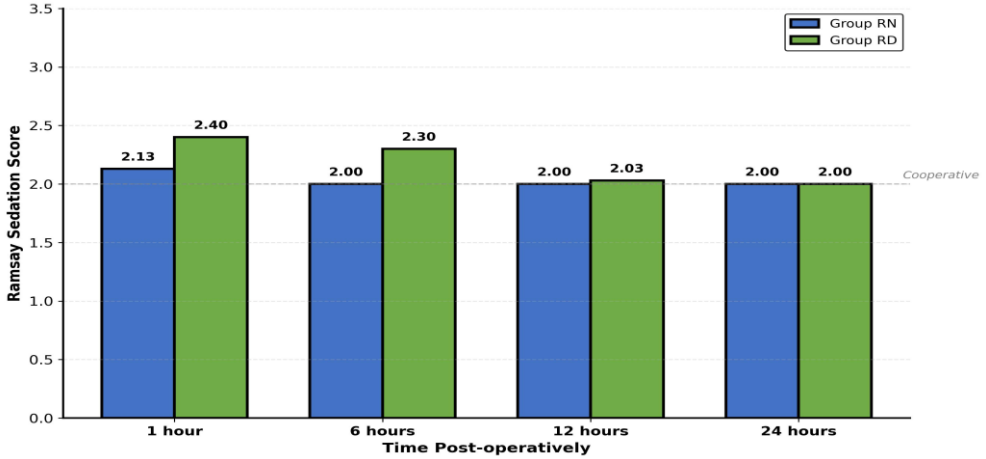


Table 10: Total Analgesic Requirement

Parameter	Group RN (n=30)	Group RD (n=30)	t-value	p-value
Total Tramadol (mg)	148.17 ± 28.93	92.03 ± 27.56	7.694	<0.001
Number of Rescue Doses	2.87 ± 0.73	1.73 ± 0.69	6.172	<0.001

Table 10 shows the total analgesic requirement in both groups over the 24-hour post-operative period. Group RD required significantly less total tramadol (92.03 ± 27.56 mg) compared to Group RN (148.17 ± 28.93 mg), representing a 37.9% reduction (p<0.001). Similarly, the number of rescue analgesic doses was significantly lower in Group RD (1.73 ± 0.69) compared to Group RN (2.87 ± 0.73), demonstrating the opioid-sparing effect of dexmedetomidine.

Figure 10: Comparison of Analgesic Requirements Between Groups

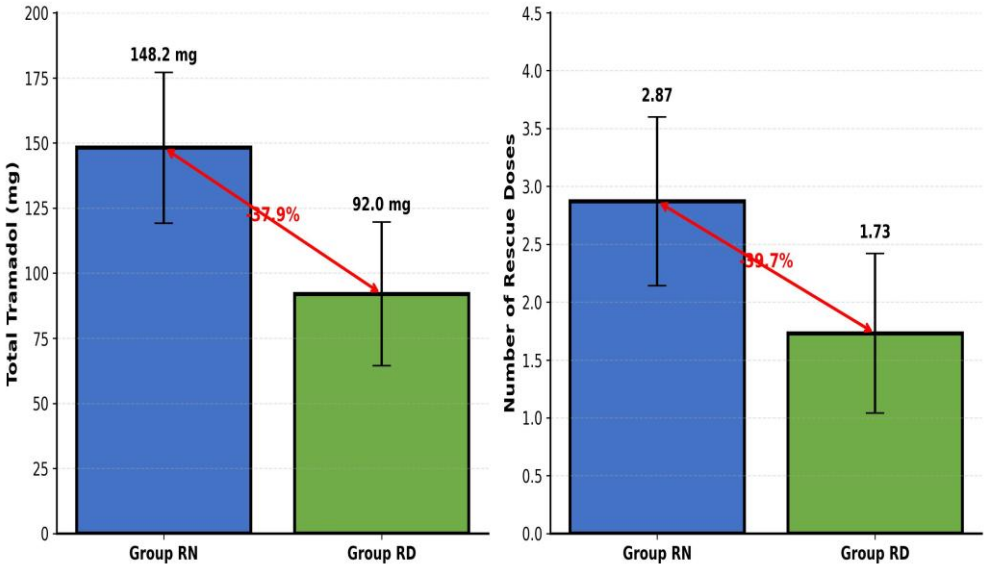
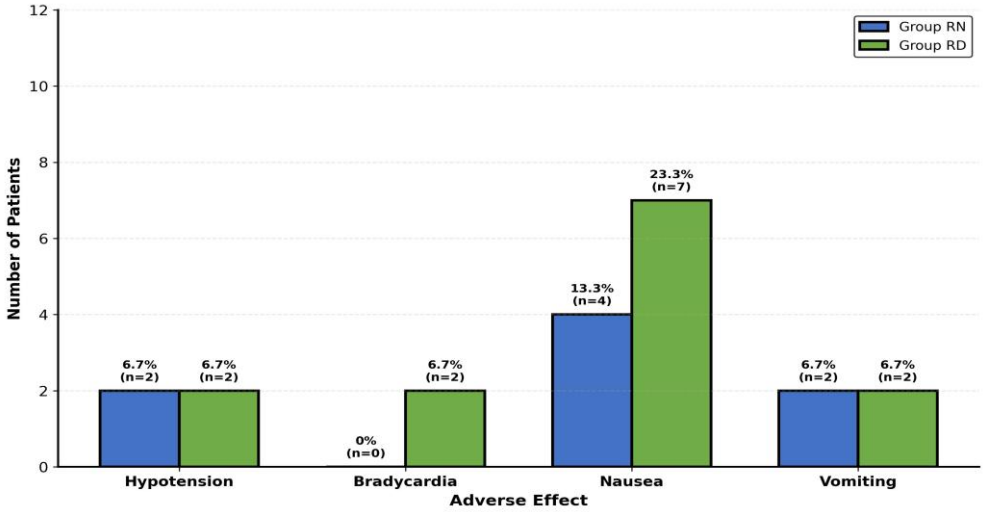


Table 11: Adverse Effects

Adverse Effect	Group RN (n=30)	Group RD (n=30)	p-value (Fisher's exact)
Hypotension	2 (6.67%)	2 (6.67%)	1.000
Bradycardia	0 (0.00%)	2 (6.67%)	0.492
Nausea	4 (13.33%)	7 (23.33%)	0.506
Vomiting	2 (6.67%)	2 (6.67%)	1.000

Table 11 illustrates the incidence of adverse effects in both study groups. Hypotension occurred in 2 patients (6.67%) in each group. Bradycardia was observed in 2 patients (6.67%) in Group RD only, though this was not statistically significant (p=0.492). Nausea was more frequent in Group RD (23.33% vs 13.33%), but the difference was not significant (p=0.506). Vomiting occurred equally in both groups. Overall, the adverse effect profile was comparable between groups.

Figure 11: Incidence of Adverse Effects in Study Groups



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