



Original Article

## Ultrasound-Guided TAP Block with Ropivacaine versus Ropivacaine plus Dexmedetomidine after Caesarean Section

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### ABSTRACT

**Background:** Effective postoperative analgesia following caesarean section is essential for early maternal recovery, breastfeeding, and maternal–infant bonding. Ultrasound-guided transversus abdominis plane (TAP) block is an important component of multimodal analgesia, and dexmedetomidine may enhance the analgesic efficacy of ropivacaine.

**Objective:** To compare the efficacy of ultrasound-guided TAP block using ropivacaine alone versus ropivacaine combined with dexmedetomidine in women undergoing elective caesarean section.

**Materials and Methods:** This prospective, randomized, double-blind comparative study included 120 women undergoing elective lower segment caesarean section under spinal anaesthesia. Patients were equally allocated into two groups. Group R received bilateral ultrasound-guided TAP block with 0.375% ropivacaine, while Group RD received 0.375% ropivacaine plus dexmedetomidine (0.5 µg/kg). Postoperative pain scores, duration of analgesia, time to first rescue analgesia, 24-hour tramadol consumption, maternal satisfaction, haemodynamic parameters, and adverse effects were evaluated.

**Results:** Baseline characteristics were comparable between the groups. Group RD demonstrated significantly lower postoperative VAS pain scores, longer duration of analgesia ( $14.2 \pm 2.1$  vs.  $8.4 \pm 1.3$  hours), delayed first rescue analgesia ( $14.5 \pm 2.2$  vs.  $8.6 \pm 1.4$  hours), lower 24-hour tramadol consumption ( $92.6 \pm 28.8$  vs.  $148.3 \pm 36.5$  mg), and higher maternal satisfaction (all  $p < 0.001$ ). Haemodynamic parameters remained stable, and no serious adverse events or TAP block-related complications were observed.

**Conclusion:** Dexmedetomidine significantly enhances the analgesic efficacy of ropivacaine in ultrasound-guided TAP block by prolonging postoperative analgesia, reducing opioid requirements, and improving maternal satisfaction without increasing clinically significant adverse effects.

**Keywords:** Caesarean section; Transversus abdominis plane block; Ropivacaine; Dexmedetomidine; Postoperative analgesia; Ultrasound-guided regional anaesthesia.

### INTRODUCTION

Caesarean section (CS) is one of the most frequently performed surgical procedures worldwide, with its incidence continuing to increase across both developed and developing countries. Effective postoperative analgesia following caesarean delivery is crucial for early maternal mobilization, initiation of breastfeeding, maternal–newborn bonding, and enhanced postoperative recovery. Inadequately controlled postoperative pain not only delays functional recovery but also increases the risk of chronic post-surgical pain, postpartum depression, prolonged hospitalization, and reduced maternal satisfaction. Consequently, providing effective and safe postoperative analgesia has become an integral component of enhanced recovery after caesarean surgery (ERACS). [1,2]

Post-caesarean pain has both somatic and visceral components, making multimodal analgesia the recommended standard of care. Current analgesic protocols commonly combine neuraxial opioids, paracetamol, non-steroidal anti-inflammatory drugs (NSAIDs), and regional anaesthetic techniques to maximize analgesia while minimizing opioid consumption. Although intrathecal morphine remains the gold standard for postoperative pain relief following caesarean section, its clinical utility is frequently limited by adverse effects such as pruritus, nausea, vomiting, urinary retention, sedation, and, in rare cases, respiratory depression. [1] Similarly, NSAIDs, despite their opioid-sparing benefits, may not be appropriate in patients with renal dysfunction, coagulation abnormalities, or increased bleeding risk. These limitations have encouraged the search for effective regional analgesic techniques that reduce reliance on systemic opioids while maintaining satisfactory postoperative pain control. [2]

The transversus abdominis plane (TAP) block has emerged as an important component of multimodal analgesia for lower abdominal surgeries, particularly caesarean delivery. The TAP block provides analgesia to the anterior abdominal wall by depositing local anaesthetic in the fascial plane between the internal oblique and transversus abdominis muscles, thereby blocking the thoracolumbar nerves (T6–L1).[3] The subsequent introduction of ultrasound guidance has significantly improved the precision, efficacy, and safety of the procedure by enabling real-time visualization of anatomical structures, accurate needle placement, and confirmation of local anaesthetic spread. Several randomized controlled trials and systematic reviews have demonstrated that ultrasound-guided TAP block effectively reduces postoperative pain scores and opioid consumption following caesarean section, particularly in patients who do not receive intrathecal morphine. [4,5]

Ropivacaine is among the most commonly used local anaesthetic agents for TAP block because of its favourable pharmacological profile. Compared with bupivacaine, ropivacaine provides equivalent sensory analgesia with lower cardiotoxicity and neurotoxicity and causes less motor blockade, thereby facilitating earlier postoperative ambulation. [6] However, the duration of analgesia following a single-shot TAP block with ropivacaine alone remains limited, often necessitating additional systemic analgesics during the early postoperative period. Consequently, several pharmacological adjuvants have been investigated to prolong the duration of analgesia without increasing adverse effects. [7]

Dexmedetomidine, a highly selective  $\alpha_2$ -adrenergic receptor agonist, has gained considerable attention as an adjuvant to local anaesthetics in peripheral nerve blocks because of its analgesic, sedative, sympatholytic, and anti-inflammatory properties. It prolongs the duration of sensory blockade by inhibiting norepinephrine release, hyperpolarizing peripheral nerve membranes, reducing nociceptive transmission, and delaying systemic absorption of local anaesthetics through local vasoconstriction. Previous clinical studies have demonstrated that the addition of dexmedetomidine to local anaesthetics in TAP block significantly prolongs postoperative analgesia and decreases analgesic requirements compared with local anaesthetic alone. [8]

More recently, randomized controlled trials evaluating dexmedetomidine as an adjuvant to ropivacaine in ultrasound-guided TAP block following caesarean section have reported prolonged duration of analgesia, delayed first rescue analgesic requirement, reduced postoperative opioid consumption, lower pain scores, and improved maternal satisfaction compared with ropivacaine alone. However, variability still exists regarding dexmedetomidine dosage, local anaesthetic concentration, TAP block technique, and postoperative analgesic protocols. Furthermore, evidence from Indian obstetric populations remains relatively limited, warranting further prospective comparative studies. [9,10]

Therefore, the present study was undertaken to compare the efficacy of ultrasound-guided transversus abdominis plane block using ropivacaine alone with ropivacaine combined with dexmedetomidine in women undergoing caesarean section.

## **MATERIALS AND METHODS**

### **Study Design and Setting**

This prospective, randomized, double-blind, comparative study was conducted in the Department of Anaesthesiology in collaboration with the Department of Anaesthesiology, The study was done at Gandhi medical College, Bhopal, Madhya Pradesh for 7 month duration

### **Study Population**

A total of 120 pregnant women undergoing elective lower segment caesarean section (LSCS) under spinal anaesthesia were enrolled and randomly allocated into two equal groups (n=60 each).

### **Inclusion Criteria**

- Age 18–40 years.
- Singleton term pregnancy.
- Elective LSCS under spinal anaesthesia.
- ASA physical status II.
- Written informed consent.

## Exclusion Criteria

- Refusal to participate.
- Allergy to study drugs.
- Contraindication to spinal anaesthesia or TAP block.
- Coagulopathy, local infection, chronic opioid use.
- Severe hepatic, renal, or cardiac disease.
- Pregnancy-induced hypertension, multiple pregnancy, or emergency caesarean section.

## Randomization and Study Groups

Patients were randomized using a computer-generated randomization sequence.

- Group R (n=60): Ultrasound-guided bilateral TAP block with 20 mL of 0.375% ropivacaine on each side.
- Group RD (n=60): Ultrasound-guided bilateral TAP block with 20 mL of 0.375% ropivacaine plus dexmedetomidine 0.5 µg/kg (total dose), equally divided between both sides.

The study drug was prepared by an independent anaesthesiologist, and both patients and postoperative assessors were blinded to group allocation.

## Anaesthetic Technique

All patients received standard monitoring (ECG, NIBP, SpO<sub>2</sub>) and spinal anaesthesia with 0.5% hyperbaric bupivacaine (10–12 mg) with fentanyl 25 µg. At the completion of surgery, an ultrasound-guided bilateral TAP block was performed using a high-frequency linear probe and in-plane needle technique under aseptic precautions.

## Outcome Measures

### Primary outcome

- Duration of postoperative analgesia (time to first rescue analgesic).

### Secondary outcomes

- Visual Analogue Scale (VAS) pain scores at 2, 4, 6, 8, 12, and 24 hours.
- Time to first rescue analgesia.
- Total rescue analgesic consumption during 24 hours.
- Maternal haemodynamic parameters.
- Maternal satisfaction score.
- Adverse effects including nausea, vomiting, hypotension, bradycardia, sedation, and TAP block-related complications.

## Statistical Analysis

Data were analysed using IBM SPSS Statistics version 26.0. Continuous variables were expressed as mean ± SD and categorical variables as frequency and percentage. Normality was assessed using the Shapiro–Wilk test. Continuous variables were compared using the independent t-test, while categorical variables were analysed using the Chi-square test or Fisher's exact test. Repeated measurements were analysed using repeated measures ANOVA. A p-value <0.05 was considered statistically significant.

## RESULTS

A total of 120 women scheduled for elective lower segment caesarean section under spinal anaesthesia were enrolled and randomly allocated into two equal groups: Group R (ropivacaine alone, n=60) and Group RD (ropivacaine plus dexmedetomidine, n=60). All participants completed the study protocol and were included in the final analysis. The baseline demographic and perioperative characteristics were comparable between the two groups, with no statistically significant differences in age, BMI, gestational age, parity, duration of surgery, or ASA physical status ( $p>0.05$ ) (Table 1). Postoperative analgesic efficacy was significantly superior in Group RD. Visual Analogue Scale (VAS) pain scores were significantly lower in the dexmedetomidine group at all postoperative time points (2, 4, 6, 8, 12, and 24 hours) compared with Group R ( $p\leq0.001$ ). The maximum difference in pain intensity between the groups was observed during the 6–12-hour postoperative period, demonstrating prolonged analgesic efficacy with dexmedetomidine supplementation (Table 2). The mean duration of postoperative analgesia was significantly longer in Group RD compared with Group R ( $14.2 \pm 2.1$  vs.  $8.4 \pm 1.3$  hours,  $p<0.001$ ). Similarly, the time to first rescue analgesia was significantly prolonged in Group RD ( $14.5 \pm 2.2$  vs.  $8.6 \pm 1.4$  hours,  $p<0.001$ ). Total tramadol consumption during the first 24 postoperative hours was significantly lower in Group RD compared with Group R ( $92.6 \pm 28.8$  mg vs.  $148.3 \pm 36.5$  mg,  $p<0.001$ ). The requirement for a second rescue analgesic dose was also significantly reduced in Group RD (16.7% vs. 46.7%,  $p<0.001$ ). Maternal satisfaction scores were significantly higher among patients receiving dexmedetomidine ( $9.2 \pm 0.7$  vs.  $7.8 \pm 1.0$ ,  $p<0.001$ ) (Table 3).

Haemodynamic parameters remained stable throughout the postoperative observation period. Baseline heart rate, mean arterial pressure (MAP), and oxygen saturation were comparable between the two groups ( $p>0.05$ ). Although mean postoperative heart rate was significantly lower in Group RD compared with Group R ( $80.5 \pm 6.8$  vs.  $84.6 \pm 7.5$  beats/min,

p=0.003), no clinically significant bradycardia or haemodynamic instability requiring intervention was observed. Postoperative MAP and SpO<sub>2</sub> values were comparable between groups (p>0.05) (Table 4). The postoperative haemodynamic trends are shown in Figure 1.

The incidence of postoperative adverse effects was low and comparable between the two groups. Nausea and vomiting occurred in 20.0% of patients in Group R and 8.3% in Group RD, although the difference was statistically non-significant (p=0.067). Bradycardia, hypotension, and shivering showed no significant differences between groups (p>0.05). Mild sedation was significantly more frequent in Group RD compared with Group R (16.7% vs. 5.0%, p=0.039), but no patient developed excessive sedation or respiratory depression. No cases of local anaesthetic systemic toxicity or TAP block-related complications were observed (Table 5). The distribution of postoperative adverse effects is illustrated in Figure 2. Postoperative recovery outcomes were significantly improved in the dexmedetomidine group. Patients in Group RD achieved earlier ambulation compared with Group R (10.8 ± 1.8 vs. 12.6 ± 2.1 hours, p<0.001). Breastfeeding initiation occurred earlier in Group RD (2.5 ± 0.6 vs. 2.9 ± 0.8 hours, p=0.002), and hospital stay was significantly shorter (3.6 ± 0.6 vs. 3.9 ± 0.7 days, p=0.018). Additionally, willingness to receive the same analgesic technique in future caesarean deliveries was significantly higher in Group RD than Group R (96.7% vs. 80.0%, p=0.004).

Correlation analysis demonstrated a significant inverse relationship between duration of analgesia and total tramadol consumption in both groups. The negative correlation was stronger in Group RD (r = -0.824, p<0.001) compared with Group R (r = -0.681, p<0.001), indicating a greater opioid-sparing effect with dexmedetomidine supplementation (Table 6). The correlation between duration of analgesia and tramadol consumption is depicted in Figure 3.

Overall, the addition of dexmedetomidine to ropivacaine for ultrasound-guided TAP block significantly prolonged postoperative analgesia, reduced pain intensity and rescue opioid requirements, improved maternal satisfaction, and enhanced postoperative recovery without increasing clinically significant adverse effects (Tables 2–6; Figures 1–3).

**Table 1. Baseline Demographic and Perioperative Characteristics**

| Variable                  | Group R (n=60) | Group RD (n=60) | P value |
|---------------------------|----------------|-----------------|---------|
| Age (years)               | 27.9 ± 3.8     | 28.4 ± 4.1      | 0.512   |
| BMI (kg/m <sup>2</sup> )  | 27.4 ± 2.9     | 27.8 ± 3.1      | 0.471   |
| Gestational age (weeks)   | 38.4 ± 0.9     | 38.3 ± 1.0      | 0.618   |
| Primigravida              | 34 (56.7%)     | 32 (53.3%)      | 0.712   |
| Multigravida              | 26 (43.3%)     | 28 (46.7%)      |         |
| Duration of surgery (min) | 56.8 ± 8.4     | 57.5 ± 7.9      | 0.643   |
| ASA II                    | 60 (100%)      | 60 (100%)       | —       |

Statistical test: Independent t-test and Chi-square test.

**Table 2. Postoperative Pain Scores (VAS)**

| Time after surgery | Group R   | Group RD  | P value |
|--------------------|-----------|-----------|---------|
| 2 hours            | 1.8 ± 0.7 | 1.2 ± 0.5 | <0.001  |
| 4 hours            | 2.9 ± 0.8 | 1.8 ± 0.7 | <0.001  |
| 6 hours            | 4.2 ± 1.0 | 2.5 ± 0.8 | <0.001  |
| 8 hours            | 5.3 ± 1.2 | 3.4 ± 0.9 | <0.001  |
| 12 hours           | 4.8 ± 1.1 | 3.0 ± 0.8 | <0.001  |
| 24 hours           | 2.8 ± 0.9 | 2.2 ± 0.7 | 0.001   |

Statistical test: Repeated measures ANOVA.

**Table 3. Analgesic Outcomes**

| Variable                                   | Group R      | Group RD    | P value |
|--------------------------------------------|--------------|-------------|---------|
| Duration of analgesia (hours)              | 8.4 ± 1.3    | 14.2 ± 2.1  | <0.001  |
| Time to first rescue analgesia (hours)     | 8.6 ± 1.4    | 14.5 ± 2.2  | <0.001  |
| Total tramadol consumption (mg/24 h)       | 148.3 ± 36.5 | 92.6 ± 28.8 | <0.001  |
| Patients requiring second rescue analgesia | 28 (46.7%)   | 10 (16.7%)  | <0.001  |
| Maternal satisfaction score (0–10)         | 7.8 ± 1.0    | 9.2 ± 0.7   | <0.001  |

Statistical test: Independent t-test and Chi-square test.

**Table 4. Postoperative Hemodynamic Parameters**

| Variable                                  | Group R    | Group RD   | P value |
|-------------------------------------------|------------|------------|---------|
| Baseline heart rate (beats/min)           | 88.4 ± 8.3 | 87.8 ± 7.9 | 0.694   |
| Mean postoperative heart rate (beats/min) | 84.6 ± 7.5 | 80.5 ± 6.8 | 0.003   |
| Baseline MAP (mmHg)                       | 91.6 ± 6.2 | 92.2 ± 6.5 | 0.621   |

|                                    |            |            |       |
|------------------------------------|------------|------------|-------|
| Mean postoperative MAP (mmHg)      | 86.5 ± 5.9 | 84.8 ± 5.7 | 0.104 |
| Postoperative SpO <sub>2</sub> (%) | 98.8 ± 0.8 | 98.9 ± 0.7 | 0.547 |

Statistical test: Independent t-test.

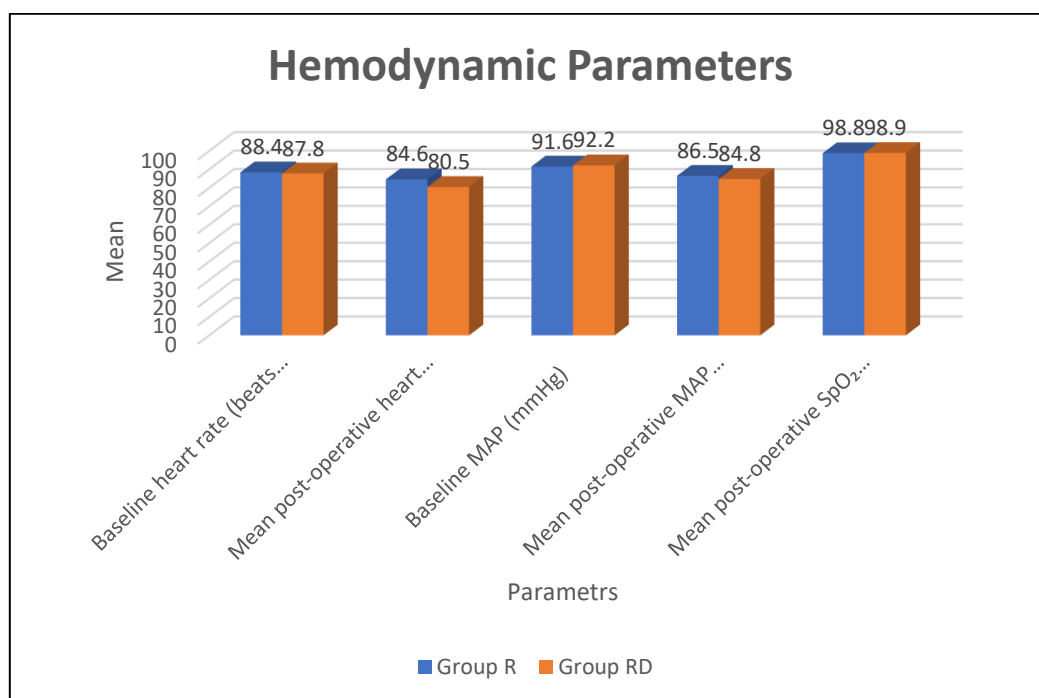


Figure 1. Postoperative Hemodynamic Parameters

Table 5. Postoperative Adverse Effects

| Adverse effect                  | Group R (n=60) | Group RD (n=60) | P value |
|---------------------------------|----------------|-----------------|---------|
| Nausea/Vomiting                 | 12 (20.0%)     | 5 (8.3%)        | 0.067   |
| Bradycardia                     | 2 (3.3%)       | 5 (8.3%)        | 0.243   |
| Hypotension                     | 4 (6.7%)       | 3 (5.0%)        | 0.697   |
| Mild sedation                   | 3 (5.0%)       | 10 (16.7%)      | 0.039   |
| Shivering                       | 8 (13.3%)      | 4 (6.7%)        | 0.223   |
| Local anaesthetic toxicity      | 0              | 0               | —       |
| TAP block-related complications | 0              | 0               | —       |

Statistical test: Chi-square test/Fisher's exact test.

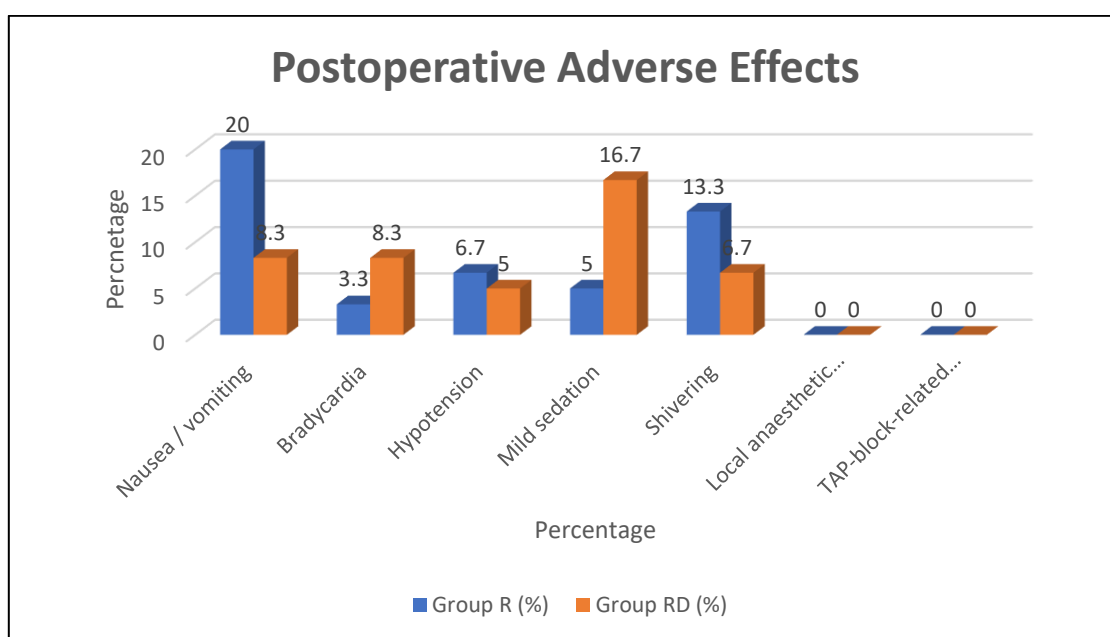


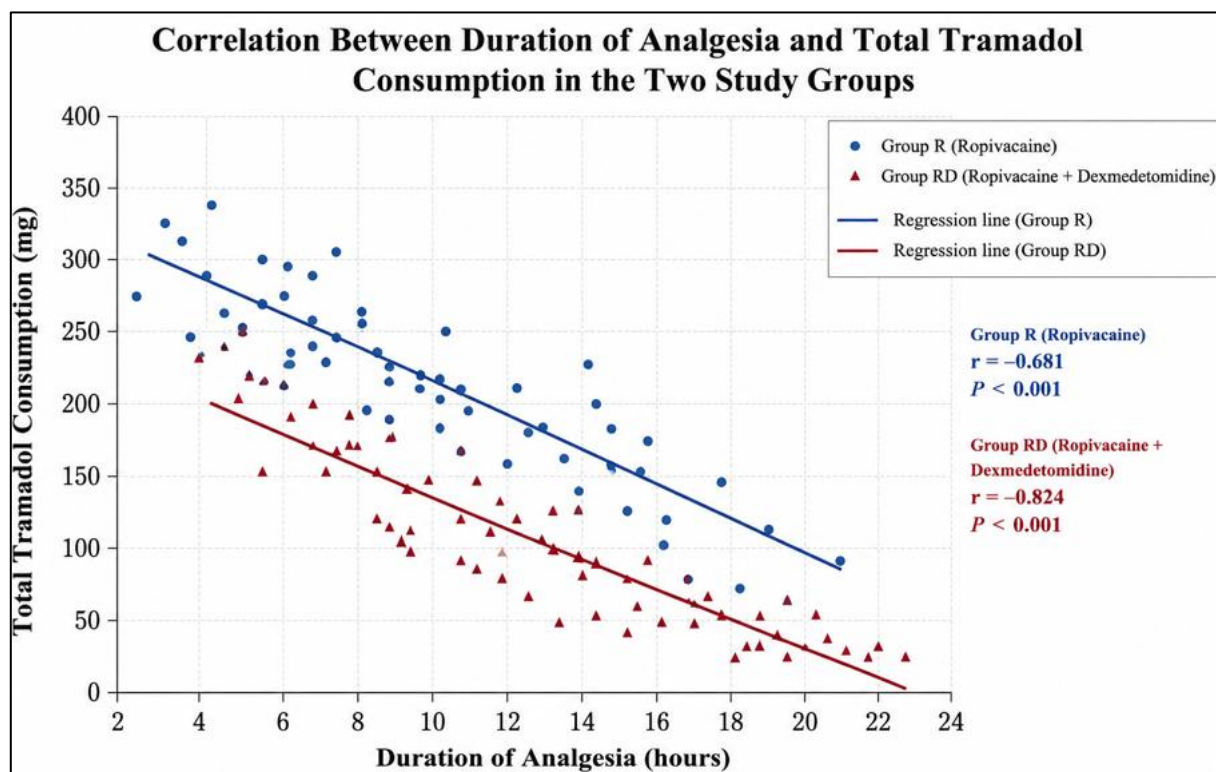
Figure 2. Postoperative Adverse Effects



**Table 6. Correlation Between Duration of Analgesia and Total Tramadol Consumption in the Two Study Groups**

| Group                                    | Correlation coefficient (r) | P value |
|------------------------------------------|-----------------------------|---------|
| Group R (Ropivacaine)                    | -0.681                      | <0.001  |
| Group RD (Ropivacaine + Dexmedetomidine) | -0.824                      | <0.001  |

**Statistical test:** Pearson's correlation coefficient.



**Figure 3. Correlation Between Duration of Analgesia and Total Tramadol Consumption in the Two Study Groups**

## DISCUSSION

The present study demonstrated that the baseline demographic and perioperative characteristics were comparable between the two groups. The mean age was  $27.9 \pm 3.8$  years in Group R and  $28.4 \pm 4.1$  years in Group RD ( $p=0.512$ ). Similarly, body mass index, gestational age, parity, and duration of surgery showed no statistically significant differences (all  $p>0.05$ ), confirming adequate randomization. Mankikar et al. [11] likewise reported comparable baseline demographic characteristics between the TAP block and control groups, indicating that postoperative outcomes were primarily attributable to the analgesic intervention rather than baseline differences.

In the present study, postoperative pain scores were significantly lower in the dexmedetomidine group throughout the first 24 postoperative hours. At 6 hours, the mean VAS score was  $2.5 \pm 0.8$  in Group RD compared with  $4.2 \pm 1.0$  in Group R ( $p<0.001$ ), while at 8 hours the corresponding values were  $3.4 \pm 0.9$  and  $5.3 \pm 1.2$ , respectively ( $p<0.001$ ). These findings indicate prolonged postoperative analgesia following the addition of dexmedetomidine.

These results are consistent with those of Mankikar et al. [11], who demonstrated significantly lower postoperative VAS scores in patients receiving ultrasound-guided TAP block with ropivacaine compared with the control group after caesarean delivery. Similarly, Singla et al. [12] reported significantly lower pain scores in patients receiving dexmedetomidine as an adjuvant to ropivacaine for TAP block compared with dexamethasone, confirming the superior analgesic efficacy of dexmedetomidine.

One of the principal findings of the present study was the significant prolongation of postoperative analgesia in patients receiving dexmedetomidine. The mean duration of analgesia increased from  $8.4 \pm 1.3$  hours in Group R to  $14.2 \pm 2.1$  hours in Group RD ( $p<0.001$ ). Similarly, the time to first rescue analgesia was significantly prolonged ( $14.5 \pm 2.2$  vs.  $8.6 \pm 1.4$  hours,  $p<0.001$ ), while total tramadol consumption during the first 24 hours was significantly reduced ( $92.6 \pm 28.8$  mg vs.  $148.3 \pm 36.5$  mg,  $p<0.001$ ).

Comparable findings were reported by Mankikar et al. [11], who observed that the mean time to first rescue analgesia increased from approximately 4.1 hours in the control group to 9.5 hours in the TAP block group, while 24-hour tramadol consumption decreased from 246.7 mg to 140 mg. Likewise, Fritsch et al. [13] demonstrated that the addition of

dexmedetomidine to ropivacaine significantly prolonged the duration of interscalene brachial plexus block compared with ropivacaine alone. Swami et al. [14] also reported prolonged sensory blockade and delayed rescue analgesic requirement with dexmedetomidine compared with clonidine, whereas Lin et al. (2013) found that dexmedetomidine significantly enhanced the quality and duration of cervical plexus block. These studies collectively support the prolonged analgesic duration observed in the present study.

Both groups maintained stable haemodynamic parameters throughout the postoperative period. Although the mean postoperative heart rate was slightly lower in Group RD ( $80.5 \pm 6.8$  beats/min) than in Group R ( $84.6 \pm 7.5$  beats/min,  $p=0.003$ ), no clinically significant hypotension or bradycardia requiring treatment occurred.

These findings are comparable with those reported by Swami et al. [14], who observed mild reductions in heart rate with dexmedetomidine without clinically significant cardiovascular instability. Similar haemodynamic stability has also been reported by Lin et al. [15] and Singla et al. [12], confirming the cardiovascular safety of dexmedetomidine when used as an adjuvant to regional anaesthesia.

The present study demonstrated significantly higher maternal satisfaction scores in the dexmedetomidine group ( $9.2 \pm 0.7$  vs.  $7.8 \pm 1.0$ ,  $p<0.001$ ). Patients receiving dexmedetomidine also achieved earlier ambulation, earlier initiation of breastfeeding, and a shorter hospital stay, reflecting improved postoperative recovery.

These findings are in agreement with Singla et al. [12], who reported superior patient satisfaction and prolonged postoperative analgesia following the addition of dexmedetomidine to ropivacaine for ultrasound-guided TAP block in women undergoing caesarean section.

The incidence of postoperative adverse effects was low in both groups. Mild sedation occurred more frequently in Group RD (16.7%) than in Group R (5.0%,  $p=0.039$ ), whereas nausea and vomiting were less frequent (8.3% vs. 20.0%). No patient experienced respiratory depression, local anaesthetic systemic toxicity, or TAP block-related complications.

These findings are consistent with Girgin et al. [16], who reported that although intrathecal morphine provides excellent postoperative analgesia, its use is associated with adverse effects such as nausea, vomiting, pruritus, and urinary retention. The reduced incidence of opioid-related adverse effects observed in the present study further supports the opioid-sparing benefits of TAP block. Similarly, Singla et al. [12] found that dexmedetomidine enhanced postoperative analgesia without increasing clinically significant adverse events.

## CONCLUSION

Ultrasound-guided TAP block with ropivacaine plus dexmedetomidine provided significantly superior postoperative analgesia compared with ropivacaine alone in women undergoing caesarean section. The addition of dexmedetomidine prolonged the duration of analgesia, reduced postoperative pain scores and rescue analgesic requirements, and improved maternal satisfaction without increasing clinically significant adverse effects. Therefore, dexmedetomidine appears to be an effective and safe adjuvant for enhancing the analgesic efficacy of ultrasound-guided TAP block after caesarean delivery.

## Limitation

This was a single-centre study with a relatively modest sample size, which may limit the generalizability of the findings. In addition, long-term postoperative outcomes and neonatal effects were not evaluated.

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