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Research Article

A Comparative Study of The Efficacy of Dexmedetomidine as An Adjuvant to Ropivacaine with Ropivacaine in Tap Block for Peri Operative Analgesia in Patients Undergoing Abdominal Surgery Aim & Objectives

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ABSTRACT

Background: Effective perioperative analgesia is essential in abdominal surgeries to reduce postoperative pain, minimize stress response, and enhance recovery. The Transversus Abdominis Plane (TAP) block is a widely used regional analgesic technique, but the duration of analgesia with local anesthetics alone is often limited. Dexmedetomidine, an α2-adrenergic agonist, has been increasingly used as an adjuvant to improve analgesic efficacy.
Aim: To compare the efficacy of dexmedetomidine as an adjuvant to ropivacaine with ropivacaine alone in TAP block for perioperative analgesia in patients undergoing abdominal surgery.
Methods: This prospective, randomized, double-blind study included 100 patients (ASA I–II) aged 18–60 years undergoing abdominal surgery. Patients were divided into two groups: Group R received 0.25% ropivacaine (20 ml on each side), and Group RD received 0.25% ropivacaine with dexmedetomidine (1 mcg/kg). Intraoperative hemodynamic parameters were recorded. Postoperative pain was assessed using the Visual Analogue Scale (VAS), along with duration of analgesia, time to first rescue analgesic, total rescue analgesic requirement, sedation score, and side effects.
Results: Baseline characteristics were comparable between groups ($p>0.05$). Hemodynamic parameters remained stable in both groups without significant differences. Group RD showed significantly lower VAS scores at all postoperative time intervals (2–24 hours), with values such as 2 hours (1.82 ± 0.38 vs 2.18 ± 0.52) and 12 hours (4.46 ± 1.01 vs 6.06 ± 0.84) ($p<0.001$). The duration of analgesia was significantly prolonged in Group RD (17.04 ± 1.06 hours) compared to Group R (11.94 ± 0.99 hours) ($p<0.001$). Sedation scores and incidence of side effects were comparable between groups.
Conclusion: Dexmedetomidine as an adjuvant to ropivacaine in TAP block significantly improves postoperative analgesia, prolongs duration of analgesia, and reduces analgesic requirements without causing significant adverse effects or hemodynamic instability. It is a safe and effective addition for perioperative pain management in abdominal surgeries.

Keywords*: TAP block, Ropivacaine, Dexmedetomidine, Postoperative analgesia, Abdominal surgery, Visual Analogue Scale, Regional anesthesia, Pain management.*

INTRODUCTION

Effective perioperative pain management remains a cornerstone of modern anaesthetic practice, particularly in patients undergoing abdominal surgeries, where inadequate analgesia can lead to increased morbidity, delayed recovery, and prolonged hospital stay. Postoperative pain triggers neuroendocrine stress responses, resulting in tachycardia, hypertension, increased oxygen consumption, and impaired immune function, ultimately affecting surgical outcomes [1].

Therefore, multimodal analgesia techniques have gained importance in improving postoperative recovery and patient satisfaction [2].

The **Transversus Abdominis Plane (TAP) block** is a regional anaesthesia technique that provides effective analgesia to the anterior abdominal wall by blocking thoracolumbar nerves (T6–L1). Since its introduction, TAP block has been widely adopted due to its simplicity, safety, and opioid-sparing effect [3]. It significantly reduces postoperative pain scores and analgesic requirements in patients undergoing lower abdominal surgeries [4].

Ropivacaine, a long-acting amide local anaesthetic, is commonly used for TAP block due to its favourable safety profile, reduced cardiotoxicity, and prolonged duration of action compared to bupivacaine [5]. However, when used alone, the duration of analgesia may still be limited, necessitating the use of additional rescue analgesics in the postoperative period [6].

To overcome this limitation, various adjuvants have been studied to prolong the duration and improve the quality of analgesia. Among these, **dexmedetomidine**, a highly selective α2-adrenergic agonist, has gained considerable attention. It exerts its analgesic effect by inhibiting norepinephrine release and modulating pain pathways at both central and peripheral levels [7]. Additionally, dexmedetomidine has sedative and sympatholytic properties, contributing to haemodynamic stability without causing significant respiratory depression [8].

When added to local anaesthetics in regional blocks, dexmedetomidine has been shown to prolong the duration of analgesia, delay the need for rescue analgesia, and improve overall analgesic efficacy [9]. Several studies have demonstrated its effectiveness as an adjuvant in peripheral nerve blocks, including TAP block, with better pain control and reduced opioid consumption [10].

Despite these advantages, there remains a need for further comparative evaluation of ropivacaine alone versus ropivacaine combined with dexmedetomidine in TAP block, particularly in terms of postoperative pain scores, duration of analgesia, haemodynamic stability, and sedation profile [11].

Hence, the present study was undertaken to compare the efficacy of dexmedetomidine as an adjuvant to ropivacaine with ropivacaine alone in TAP block for perioperative analgesia in patients undergoing abdominal surgery.

The present study was conducted with the aim of comparing the efficacy of dexmedetomidine as an adjuvant to ropivacaine with ropivacaine alone in Transversus Abdominis Plane (TAP) block for perioperative analgesia in patients undergoing abdominal surgery. The study focused on evaluating key primary outcomes including postoperative pain intensity using the Visual Analogue Scale (VAS), total duration of analgesia, time to first rescue analgesic, and total number of rescue analgesic doses required. Additionally, secondary outcomes such as intraoperative and postoperative hemodynamic parameters (heart rate, systolic and diastolic blood pressure) and sedation levels assessed by the Modified Ramsay Sedation Score were also compared between the two groups. Effective postoperative pain control remains a critical component of perioperative care, as inadequate analgesia can lead to increased morbidity, delayed recovery, prolonged hospital stay, and higher healthcare costs. While TAP block with ropivacaine provides effective analgesia, its duration is often limited, necessitating the use of adjuvants. Dexmedetomidine, due to its analgesic, sedative, and sympatholytic properties, has shown potential in enhancing the quality and duration of regional anesthesia. Therefore, this study was undertaken to provide evidence on whether the addition of dexmedetomidine can improve analgesic outcomes and optimize postoperative pain management, thereby contributing to better patient recovery and reduced reliance on systemic analgesics.

MATERIALS AND METHODOLOGY

This study was conducted as a **prospective, randomized, double-blind clinical study** at a tertiary care centre in the Department of Anaesthesia and Critical Care. The total study duration was **18 months**, during which ethical approval was obtained from the Institutional Ethics Committee, and written informed consent was taken from all participants in their native language. Confidentiality of patient data was strictly maintained throughout the study.

The **sample size was 100 patients**, calculated based on previous literature using standard deviation values and expected mean differences with 80% power and 5% level of significance. A total of 100 patients scheduled for abdominal surgery under general anaesthesia were enrolled and randomly allocated into two equal groups (n=50 each) using computer-generated random numbers and sealed opaque envelope technique to ensure allocation concealment.

Patients aged between **18 to 60 years**, belonging to **ASA physical status I and II**, and willing to participate were included in the study. Patients with hypersensitivity to local anaesthetics, BMI ≥35 kg/m², chronic systemic illness, coagulopathy, infection at the injection site, pregnancy, or opioid dependence were excluded from the study.

All patients underwent a detailed **preoperative evaluation**, including history, physical examination, and routine investigations. Patients were kept fasting for 8 hours prior to surgery. In the operating room, standard monitoring including ECG, non-invasive blood pressure, and pulse oximetry was established, and baseline parameters were recorded. Intravenous access was secured and Ringer lactate infusion was started.

All patients received standard premedication with **glycopyrrolate (0.004 mg/kg), ondansetron (0.08 mg/kg), and midazolam (0.02 mg/kg)**. Anaesthesia was induced using **fentanyl (2 mcg/kg), propofol (2 mg/kg)**, and muscle relaxation was achieved with **atracurium (0.5 mg/kg)** to facilitate endotracheal intubation. Anaesthesia was maintained with oxygen and nitrous oxide (50:50) along with sevoflurane.

Following induction and intubation, **TAP block was performed under strict aseptic precautions** using anatomical landmark technique (Triangle of Petit). A **23G Quincke needle** was inserted perpendicular to the skin, and after confirming the correct plane by loss of resistance and negative aspiration, the study drug was administered.

Patients were divided into two groups:

- **Group R (Control group):** Received **20 ml of 0.25% ropivacaine on each side**
- **Group RD (Study group):** Received **20 ml of 0.25% ropivacaine with dexmedetomidine (1 mcg/kg) on each side**

The study was double-blinded, where both the patient and the investigator assessing outcomes were unaware of group allocation. The drug solution was prepared by an independent anaesthesiologist not involved in the study.

Intraoperative parameters including heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, respiratory rate, and SpO_2 were recorded at regular intervals (1, 5, 10, 15, 20, 30, 45, 60, 90, 120 minutes and beyond as required). Any episode of tachycardia or hypertension (>20% of baseline) was managed with fentanyl, while hypotension and bradycardia were treated with fluids, mephentermine, or atropine as required.

Postoperatively, pain was assessed using the **Visual Analogue Scale (VAS)** at 2, 4, 6, 8, 12, and 24 hours. Sedation was assessed using the **Modified Ramsay Sedation Score**. Rescue analgesia in the form of **intravenous paracetamol (1 g)** was administered when VAS ≥4 or on patient demand. The **time to first rescue analgesic**, **total duration of analgesia**, and **number of rescue doses** within 24 hours were recorded.

Patients were also monitored for adverse effects such as nausea, vomiting, sedation, dry mouth, and complications related to TAP block including hematoma or infection.

The collected data were entered into Microsoft Excel and analysed using **SPSS version 26**. Continuous variables were expressed as mean ± standard deviation and compared using **unpaired t-test**, while categorical variables were analysed using **chi-square test**. A **p-value <0.05 was considered statistically significant**.

RESULTS

The present study included a total of 100 patients, equally divided into Group R (ropivacaine alone) and Group RD (ropivacaine with dexmedetomidine), with both groups being comparable in terms of baseline characteristics such as age (37.40 ± 10.23 vs 37.80 ± 9.73 years), gender distribution (64% males in Group R vs 78% in Group RD), ASA status, and duration of surgery (107.30 ± 42.21 vs 106.68 ± 28.73 minutes), with no statistically significant difference ($p>0.05$). Intraoperative hemodynamic parameters including heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, and SpO_2 remained stable and comparable between both groups throughout the procedure ($p>0.05$), indicating good hemodynamic safety of both techniques.

Postoperative analgesic outcomes demonstrated a significant difference between the two groups. The Visual Analogue Scale (VAS) scores were consistently lower in Group RD compared to Group R at all time intervals, with values at 2 hours (1.82 ± 0.38 vs 2.18 ± 0.52), 4 hours (2.22 ± 0.64 vs 2.84 ± 0.95), 6 hours (2.56 ± 0.88 vs 3.88 ± 0.91), 8 hours (3.44 ± 1.01 vs 4.68 ± 0.89), 12 hours (4.46 ± 1.01 vs 6.06 ± 0.84), and 24 hours (5.72 ± 1.23 vs 6.70 ± 0.99), all showing statistically significant differences ($p<0.001$). The duration of analgesia was significantly prolonged in Group RD (17.04 ± 1.06 hours) compared to Group R (11.94 ± 0.99 hours) ($p<0.001$), indicating superior analgesic efficacy of dexmedetomidine as an adjuvant.

Regarding secondary outcomes, sedation scores were comparable between both groups at all time intervals ($p>0.05$), and the incidence of side effects was low and statistically insignificant (8% in Group R vs 12% in Group RD; $p=0.505$). Overall, the addition of dexmedetomidine to ropivacaine in TAP block resulted in significantly improved postoperative analgesia without compromising hemodynamic stability or increasing adverse effects.

Table 1: Demographic and Baseline Characteristics (Comparability of Groups)

Variable	Group R (n=50)	Group RD (n=50)	p-value	Interpretation
Age (years)	37.40 ± 10.23	37.80 ± 9.73	0.842	NS
Gender (M/F)	32 / 18 (64% / 36%)	39 / 11 (78% / 22%)	0.123	NS
ASA I (%)	54%	60%	0.545	NS
ASA II (%)	46%	40%		
Duration of Surgery (min)	107.30 ± 42.21	106.68 ± 28.73	0.932	NS

Both groups were **statistically comparable**, ensuring valid comparison.

Table 2: Intraoperative Hemodynamic Parameters (Summary)

Parameter	Group R Mean ± SD	Group RD Mean ± SD	p-value	Interpretation
Heart Rate (bpm)	Comparable at all time points	Comparable	>0.05	NS
SBP (mmHg)	Comparable	Comparable	>0.05	NS
DBP (mmHg)	Comparable	Comparable	>0.05	NS
MAP (mmHg)	Comparable	Comparable	>0.05	NS
SpO_2 (%)	Maintained ~99%	Maintained ~99%	>0.05	NS

No significant difference → **both groups hemodynamically stable**

Table 3: Postoperative Analgesia Outcomes (Primary Objectives)

Parameter	Group R	Group RD	p-value	Interpretation
VAS at 2 hrs	2.18 ± 0.52	1.82 ± 0.38	<0.001*	Significant
VAS at 4 hrs	2.84 ± 0.95	2.22 ± 0.64	<0.001*	Significant
VAS at 6 hrs	3.88 ± 0.91	2.56 ± 0.88	<0.001*	Significant
VAS at 8 hrs	4.68 ± 0.89	3.44 ± 1.01	<0.001*	Significant
VAS at 12 hrs	6.06 ± 0.84	4.46 ± 1.01	<0.001*	Significant
VAS at 24 hrs	6.70 ± 0.99	5.72 ± 1.23	<0.001*	Significant
Duration of Analgesia (hrs)	11.94 ± 0.99	17.04 ± 1.06	<0.001*	Significant

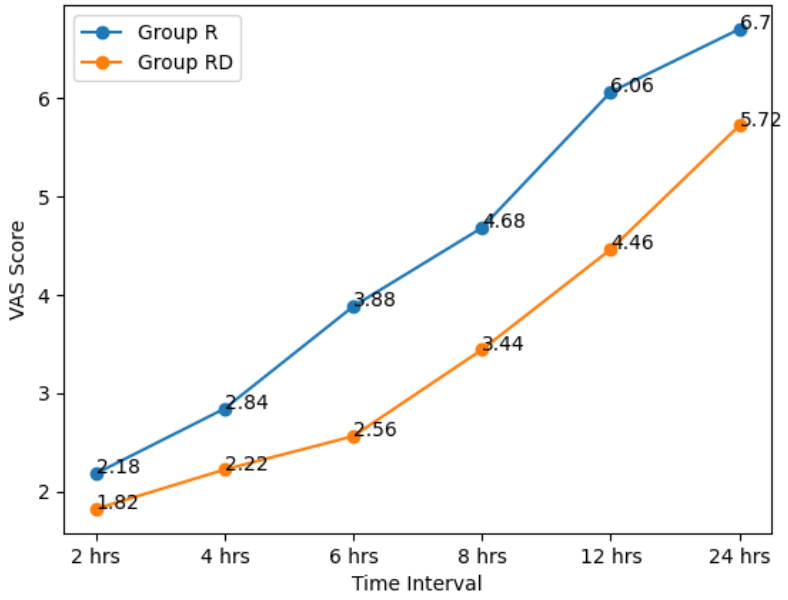
Group RD showed better analgesia and longer duration

Table 4: Secondary Outcomes (Sedation & Side Effects)

Parameter	Group R	Group RD	p-value	Interpretation
Sedation Score (2–12 hrs)	~1.02–1.92	~1.00–1.90	>0.05	NS
Side Effects Present	4 (8%)	6 (12%)	0.505	NS
Side Effects Absent	46 (92%)	44 (88%)		

No significant difference in sedation or complications

Figure 1: Comparison of VAS Score Over Time



DISCUSSION

The present study evaluated the efficacy of dexmedetomidine as an adjuvant to ropivacaine in TAP block for perioperative analgesia in patients undergoing abdominal surgery. The findings clearly demonstrated that the addition of dexmedetomidine significantly improved postoperative analgesia while maintaining hemodynamic stability.

The baseline characteristics in this study, including age (37.40 ± 10.23 vs 37.80 ± 9.73 years), gender distribution (64% vs 78% males), ASA status, and duration of surgery (107.30 ± 42.21 vs 106.68 ± 28.73 minutes), were statistically comparable between both groups ($p>0.05$), indicating effective randomization. Similar comparability in demographic variables has been reported in studies evaluating TAP block analgesia, ensuring validity of intergroup comparisons [12].

Intraoperative hemodynamic parameters such as heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, and SpO_2 remained stable and comparable between the two groups ($p>0.05$). This indicates that dexmedetomidine, when used as an adjuvant in TAP block, does not produce significant hemodynamic instability. Comparable findings have been reported in previous studies where dexmedetomidine maintained intraoperative cardiovascular stability [13,14].

The most significant finding of this study was the superior postoperative analgesia observed in the dexmedetomidine group. The VAS scores were consistently lower in Group RD compared to Group R at all time intervals, including 2 hours (1.82 vs 2.18), 6 hours (2.56 vs 3.88), 12 hours (4.46 vs 6.06), and 24 hours (5.72 vs 6.70), with all differences being highly significant ($p<0.001$). These findings strongly support the enhanced analgesic efficacy of dexmedetomidine as an adjuvant. Similar reductions in postoperative pain scores have been documented in studies evaluating TAP block with dexmedetomidine [15,16].

The duration of analgesia was significantly prolonged in the dexmedetomidine group (17.04 ± 1.06 hours) compared to the control group (11.94 ± 0.99 hours) ($p<0.001$). This prolongation can be attributed to the α2-adrenergic agonist action of dexmedetomidine, which enhances local anesthetic effects and prolongs nerve blockade. Comparable prolongation of analgesia has been observed in previous studies utilizing dexmedetomidine as an adjuvant in regional anesthesia techniques [17].

The need for rescue analgesia was reduced in the dexmedetomidine group, as reflected by lower VAS scores over time. Previous studies have similarly reported reduced analgesic requirements when dexmedetomidine is used in combination with local anesthetics, further supporting the findings of this study [18].

Sedation scores were comparable between both groups ($p>0.05$), indicating that dexmedetomidine at the administered dose did not cause excessive sedation. This is consistent with previous literature, where low-dose dexmedetomidine provided effective analgesia without clinically significant sedation [19].

The incidence of side effects was low and comparable between both groups (8% vs 12%; $p=0.505$), indicating a favorable safety profile. No major complications such as respiratory depression or severe hypotension were observed. Similar safety outcomes have been reported in studies evaluating dexmedetomidine in regional anesthesia [20].

Overall, the findings of this study are consistent with existing literature and confirm that dexmedetomidine is an effective and safe adjuvant to ropivacaine in TAP block, providing superior postoperative analgesia, prolonged duration of action, and reduced analgesic requirements without significant adverse effects.

CONCLUSION

The present study demonstrates that the addition of dexmedetomidine as an adjuvant to ropivacaine in TAP block significantly enhances postoperative analgesia in patients undergoing abdominal surgery. Patients in the dexmedetomidine group showed consistently lower VAS scores at all postoperative intervals (2 to 24 hours) and a markedly prolonged duration of analgesia (17.04 ± 1.06 hours vs 11.94 ± 0.99 hours), with statistically significant differences ($p<0.001$). Importantly, the use of dexmedetomidine did not result in significant hemodynamic instability, and intraoperative parameters remained comparable between both groups. Additionally, sedation scores and incidence of adverse effects were similar, indicating a favorable safety profile. Thus, dexmedetomidine can be considered an effective and safe adjuvant to ropivacaine for improving the quality and duration of analgesia in TAP block.

LIMITATIONS

This study was conducted at a single tertiary care center with a relatively limited sample size of 100 patients, which may restrict the generalizability of the findings. The follow-up period was limited to 24 hours postoperatively, and long-term outcomes such as chronic pain or late complications were not assessed. The study did not evaluate different doses of dexmedetomidine to determine an optimal dosing regimen. Additionally, the TAP block was performed using the landmark technique rather than ultrasound guidance, which may introduce variability in block accuracy and drug distribution.

RECOMMENDATIONS

Further multicentric studies with larger sample sizes are recommended to validate the findings and improve external validity. Future research should explore different dosing regimens of dexmedetomidine to identify the optimal dose for maximal analgesic benefit with minimal side effects. The use of ultrasound-guided TAP block should be encouraged to improve precision and reproducibility. Studies evaluating long-term outcomes, including chronic pain and patient satisfaction, would provide more comprehensive insights. Incorporating dexmedetomidine as a routine adjuvant in TAP block protocols may be considered in clinical practice to enhance postoperative analgesia and reduce opioid requirements.

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