Original Research

# ANALGESIC EFFICACY OF ROPIVACAINEWITH OR WITHOUT DEXAMETHASONE IN LANDMARK - GUIDED TRANSVERSUS ABDOMINIS PLANE BLOCK FOR PEDIATRIC LOWER ABDOMINAL SURGERY: A RANDOMIZED DOUBLE-BLIND STUDY

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## ABSTRACT

**Background**: Effective postoperative pain control in children undergoing lower abdominal surgery remains challenging because systemic opioids may cause adverse effects such as nausea, vomiting, sedation, and respiratory depression. Landmark -guided transversus abdominis plane (TAP) block is an established regional analgesic technique for abdominal wall pain. Dexamethasone has been investigated as an adjuvant to local anesthetics to prolong block duration and improve analgesic quality. This study evaluated whether adding dexamethasone to ropivacaine in landmark -guided TAP block improves postoperative analgesia in pediatric patients undergoing lower abdominal surgery.

**Aims and Objectives:** The aim of this study is to compare the efficacy of Ropivacaine and Ropivacaine with Dexamethasone in Transversus Abdominis Plane (TAP) block in pediatric patients undergoing lower abdominal surgery and to compare duration of postoperative analgesia, postoperative hemodynamic parameter and incidence of side effects between the two groups.

**Material and Methods**: In this prospective, randomized, double-blind study, 60 pediatric patients aged 1–12 years with American Society of Anesthesiologists physical status I–II scheduled for elective lower abdominal surgery under general anesthesia were randomly assigned to two groups. Group R received TAP block with 0.2% ropivacaine 0.5 mL/kg plus saline, and Group RD received 0.2% ropivacaine 0.5 mL/kg plus dexamethasone. The primary outcome was time to first rescue analgesia. Secondary outcomes included postoperative pain scores, total rescue analgesic consumption, hemodynamic variables, and adverse events. A two-sided P value $< 0.05$ was considered statistically significant.

**Results**: The mean time to first rescue analgesia was significantly longer in Group RD than in Group R (525.85 ± 81.30 min vs. 243.00 ± 97.36 min, $P < 0.001$). Postoperative pain scores were significantly lower in Group RD at 4 h, 6 h, and 12 h after surgery ($P < 0.05$). Total rescue analgesic consumption during the first 24 h was significantly reduced in Group RD compared with Group R ($P < 0.001$). Heart rate, mean arterial pressure, and oxygen saturation were comparable between groups at all measured time points ($P > 0.05$). No serious adverse events, local anesthetic toxicity, or block-related complications were observed.

**Conclusions**: Adding dexamethasone to ropivacaine in landmark -guided TAP block significantly prolonged postoperative analgesia and reduced postoperative analgesic requirements without increasing adverse effects. This combination may be an effective component of multimodal analgesia for pediatric lower abdominal surgery.

**Keywords:** Child, Dexamethasone, Postoperative Pain, Regional Anesthesia, Ropivacaine, Transversus Abdominis Plane Block.

 

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## INTRODUCTION

Effective postoperative pain management is a fundamental goal of pediatric anesthesia because inadequate analgesia may delay recovery, increase physiologic stress responses, and prolong hospital stay [1]. Children undergoing lower abdominal surgery commonly experience moderate to severe postoperative pain arising from abdominal wall incision and tissue manipulation [2]. Although systemic opioids remain widely used for postoperative analgesia, their use in pediatric patients is limited by adverse effects such as nausea, vomiting, sedation, pruritus, and respiratory depression [1]. Accordingly, opioid-sparing regional analgesic techniques have become increasingly important in contemporary perioperative practice [4].

The transversus abdominis plane (TAP) block is an established fascial plane block that provides somatic analgesia to the anterolateral abdominal wall by targeting the thoracolumbar nerves within the plane between the internal oblique and transversus abdominis muscles [3]. The TAP block can be performed using anatomical landmark techniques and provides effective somatic analgesia of the anterior abdominal wall. In pediatric patients, landmark-guided TAP block has demonstrated favorable analgesic efficacy after inguinal, urologic, and other lower abdominal procedures, while avoiding many of the limitations associated with neuraxial techniques [4]. In many low-resource settings, ultrasound is not universally available. Therefore, evaluating landmark-guided TAP block remains clinically relevant.

However, the duration of analgesia after a single-shot TAP block is restricted by the pharmacologic profile of the local anesthetic used. As the block regresses, supplemental systemic analgesics are often required during the early postoperative period [2,4]. Strategies to prolong block duration and enhance analgesic quality have therefore attracted considerable interest. Among the available adjuvants, dexamethasone has been reported to prolong peripheral nerve and fascial plane block analgesia through anti-inflammatory effects, reduced nociceptive transmission, and delayed systemic absorption of local anesthetics [5,6].

Ropivacaine is a long-acting amide local anesthetic frequently selected for pediatric regional anesthesia because of its favorable safety profile and lower potential for cardiotoxicity and neurotoxicity compared with bupivacaine [7,10]. The addition of dexamethasone to ropivacaine may further improve postoperative analgesia, but evidence in pediatric TAP block remains limited [6,8,9].

Therefore, this prospective randomized double-blind study was conducted to compare the analgesic efficacy of ropivacaine alone versus ropivacaine combined with dexamethasone in landmark-guided TAP block for pediatric patients undergoing lower abdominal surgery. The primary objective was to evaluate the time to first rescue analgesia. Secondary objectives included postoperative pain scores, rescue analgesic consumption, hemodynamic variables, and adverse events.

**Aim and Objectives:**

1. The aim of this study is to compare the efficacy of Ropivacaine and Ropivacaine with Dexamethasone in transversus abdominis plane block in pediatric patients undergoing lower abdominal surgery.
2. To study and compare the duration of post operative analgesia in both the groups.
3. To study and compare the postoperative hemodynamics in both groups.
4. To study the side effect in both the groups if any.

## MATERIALS AND METHODS

This prospective, randomized, double-blind, single-center study was conducted in the Department of Anesthesiology, J.A. Group of Hospitals and Gajra Raja Medical College, Gwalior, India, between April 2024 and February 2026. Ethical approval was obtained from the Institutional Ethics Committee of Gajra Raja Medical College before patient enrollment. Written informed consent was obtained from the parents or legal guardians of all participants. The study was conducted in accordance with the principles of the Declaration of Helsinki [11] and is reported in accordance with the CONSORT Group statement [12].

Sixty pediatric patients aged 1–12 years with American Society of Anesthesiologists (ASA) physical status I–II [13] scheduled for elective lower abdominal surgery under general anesthesia were enrolled. Lower abdominal procedures included inguinal, urologic, and related infraumbilical surgeries.

Exclusion criteria were refusal of consent by parents or guardians, ASA physical status III–IV, known hypersensitivity to local anesthetics or dexamethasone, coagulopathy, local infection at the injection site, preexisting neurologic disease, severe systemic illness, developmental conditions preventing pain assessment, and failure of block performance.

The sample size was calculated using data from a previous comparative study evaluating

dexamethasone as an adjuvant in TAP block [17]. Based on an expected difference in time to first rescue analgesia between groups, a two-sided α error of 0.05, and a power of 80%, the minimum required sample size was 30 patients per group. Therefore, 60 patients were included.

Participants were randomly assigned in a 1:1 ratio to Group R or Group RD using a computer-generated randomization sequence. Allocation concealment was achieved using sequentially numbered, sealed, opaque envelopes opened immediately before preparation of the study drug.

The study solutions were prepared by an anesthesiologist not involved in intraoperative management, block performance, or postoperative assessment. The anesthesiologist performing the block, the attending anesthesiologist, patients, caregivers, and the investigator collecting postoperative data were blinded to group allocation.

After standard fasting guidelines, all patients underwent routine preanesthetic evaluation. In the operating room, standard monitoring was applied, including noninvasive blood pressure, electrocardiography, pulse oximetry, and capnography. Baseline heart rate, mean arterial pressure, and peripheral oxygen saturation were recorded.

General anesthesia was induced with intravenous glycopyrrolate (0.005 mg/kg), midazolam (0.05 mg/kg), ketamine (2 mg/kg), and succinylcholine (2 mg/kg) to facilitate endotracheal intubation. Anesthesia was maintained with sevoflurane in a mixture of oxygen and nitrous oxide. Additional neuromuscular blockade and analgesia were administered as clinically required.

Following induction of anesthesia, a bilateral landmark-guided TAP block was performed under aseptic precautions using the triangle of Petit approach. After identifying the anatomical landmarks bounded by the external oblique, latissimus dorsi, and iliac crest, the needle was advanced perpendicular to the skin until the characteristic loss of resistance/pop sensation was appreciated. After negative aspiration, the study solution was injected into the transversus abdominis plane.

Group R received 0.2% ropivacaine 0.5 mL/kg total volume divided equally between both sides plus normal saline. Group RD received 0.2% ropivacaine 0.5 mL/kg plus dexamethasone 0.1 mg/kg added to the TAP block solution (total dose). The total injected volume was standardized for both groups.

The primary outcome was time to first rescue analgesia, defined as the interval between completion of TAP block and the first requirement for postoperative rescue analgesic medication.

Secondary outcomes included postoperative pain scores, total rescue analgesic consumption during the first 24 h, intraoperative and postoperative hemodynamic variables, and adverse events including postoperative nausea and vomiting, sedation, local anesthetic systemic toxicity, and block-related complications.

Pain was assessed postoperatively using an age-appropriate validated pain scale at predefined intervals [14,15]. Rescue analgesia was administered when FLACC or Wong-Baker Faces pain score was ≥4.

Demographic variables included age, sex, body weight, ASA physical status, and duration of surgery. Hemodynamic parameters were recorded at baseline, after induction, after block placement, intraoperatively at regular intervals, and postoperatively. Postoperative analgesic outcomes and adverse events were documented by a blinded observer.

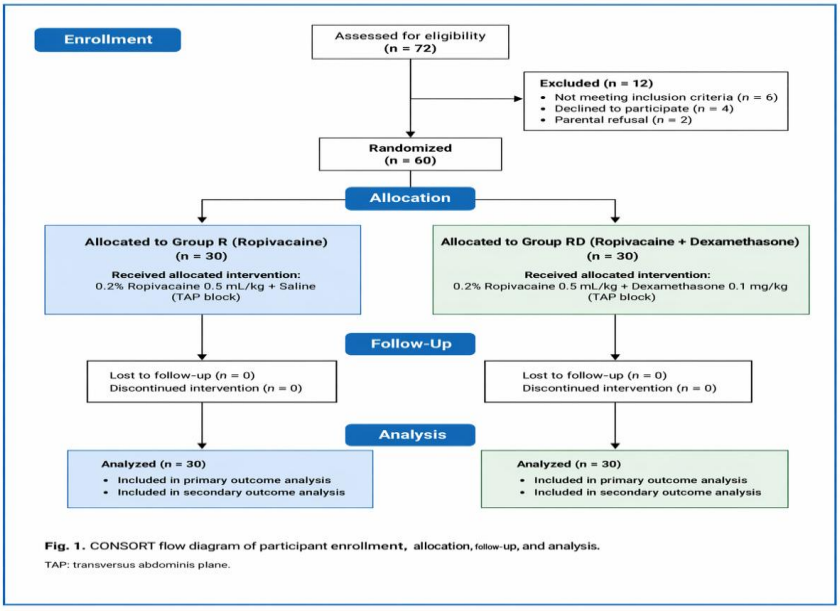



**Fig. 1.** CONSORT flow diagram of participant enrollment, allocation, follow-up, and analysis.
TAP: transversus abdominis plane.

**Statistical Analysis:** Statistical analysis was performed using standard statistical software. Continuous variables were expressed as mean ± standard deviation or median (interquartile range), as appropriate. Normality was assessed using the Shapiro–Wilk test [16]. Intergroup comparisons were performed using the independent t-test or Mann–Whitney U test. Categorical variables were presented as number (%) and compared using the chi-square test or Fisher's exact test.

A two-sided P value < 0.05 was considered statistically significant.

## RESULTS

**Study Population and Baseline Characteristics:** A total of 60 pediatric patients were assessed for eligibility, randomized, and included in the final analysis, with 30 patients allocated to each group: Group R (ropivacaine alone) and Group RD (ropivacaine plus dexamethasone) (Fig. 1). No patient was lost to follow-up or excluded after randomization.

Baseline demographic and perioperative characteristics were comparable between the groups. Mean age was 6.42 ± 2.81 years in Group R and 6.67 ± 2.94 years in Group RD (P = 0.734). Mean body weight was 18.96 ± 5.42 kg in Group R and 19.41 ± 5.88 kg in Group RD (P = 0.756). Sex distribution (male/female: 21/9 vs. 20/10; P = 0.781), ASA physical status I/II (23/7 vs. 22/8; P = 0.764), and duration of surgery (58.43 ± 14.82 vs. 60.17 ± 15.36 min; P = 0.653) were also similar between Group R and Group RD (Table 1).

Table 1. Baseline Demographic and Perioperative Characteristics

| Variable | Group R (Ropivacaine) n = 30 | Group RD (Ropivacaine + Dexamethasone) n = 30 | P value |
|---|---|---|---|
| Age (yr) | 6.42 ± 2.81 | 6.67 ± 2.94 | 0.734 |
| Body weight (kg) | 18.96 ± 5.42 | 19.41 ± 5.88 | 0.756 |
| Sex (Male/Female) | 21 / 9 | 20 / 10 | 0.781 |
| ASA physical status (I/II) | 23 / 7 | 22 / 8 | 0.764 |
| Duration of surgery (min) | 58.43 ± 14.82 | 60.17 ± 15.36 | 0.653 |

Values are presented as mean ± SD or number of patients.
ASA = American Society of Anesthesiologists.

**Primary Outcome: Time to First Rescue Analgesia:** The mean time to first rescue analgesia was significantly prolonged in Group RD compared with Group R (525.85 ± 81.30 min vs. 243.00 ± 97.36 min). The mean difference was 282.85 min (95% CI 238.44 to 327.26; P < 0.001), representing a 116.4% increase in analgesic duration with dexamethasone (Table 2).

Table 2. Primary and Secondary Analgesic Outcomes

| Outcome | Group R N = 30 | Group RD N = 30 | Effect Estimate | P Value |
|---|---|---|---|---|
| Time to first rescue analgesia (min) | 243.00 ± 97.36 | 525.85 ± 81.30 | Mean difference 282.85 min (95% CI, 238.44–327.26) | < 0.001 |
| Total rescue paracetamol in 24 h (mg) | 286.7 ± 94.5 | 173.3 ± 81.6 | Mean difference −113.4 mg (95% CI, −158.6 to −68.2) | < 0.001 |
| Repeated rescue analgesia required, n (%) | 18 (60.0) | 7 (23.3) | — | 0.004 |

Values are presented as mean ± SD or number (%).

**Postoperative Pain Scores:** Postoperative pain scores were consistently lower in Group RD than in Group R. At 2 h, mean pain scores were 1.42 ± 0.57 in Group R and 1.18 ± 0.46 in Group RD (P = 0.082). At 4 h, scores were significantly lower in Group RD (3.21 ± 0.76 vs. 2.14 ± 0.63; P < 0.001). At 6 h, pain scores remained lower in Group RD (4.08 ± 0.81 vs. 2.63 ± 0.72; P < 0.001). At 12 h, Group RD continued to demonstrate superior analgesia (3.36 ± 0.74 vs. 2.41 ± 0.61; P < 0.001). By 24 h, pain scores were comparable between groups (1.84 ± 0.52 vs. 1.67 ± 0.49; P = 0.196) (Table 3).

Table 3. Postoperative Pain Scores at Predefined Time Points

| Time After Surgery | Group R N = 30 | Group Rd N = 30 | P Value |
|---|---|---|---|
| 2 h | 1.42 ± 0.57 | 1.18 ± 0.46 | 0.082 |
| 4 h | 3.21 ± 0.76 | 2.14 ± 0.63 | < 0.001 |
| 6 h | 4.08 ± 0.81 | 2.63 ± 0.72 | < 0.001 |
| 12 h | 3.36 ± 0.74 | 2.41 ± 0.61 | < 0.001 |
| 24 h | 1.84 ± 0.52 | 1.67 ± 0.49 | 0.196 |

Values are presented as mean ± SD.
Pain was assessed using age-appropriate validated pain scales.

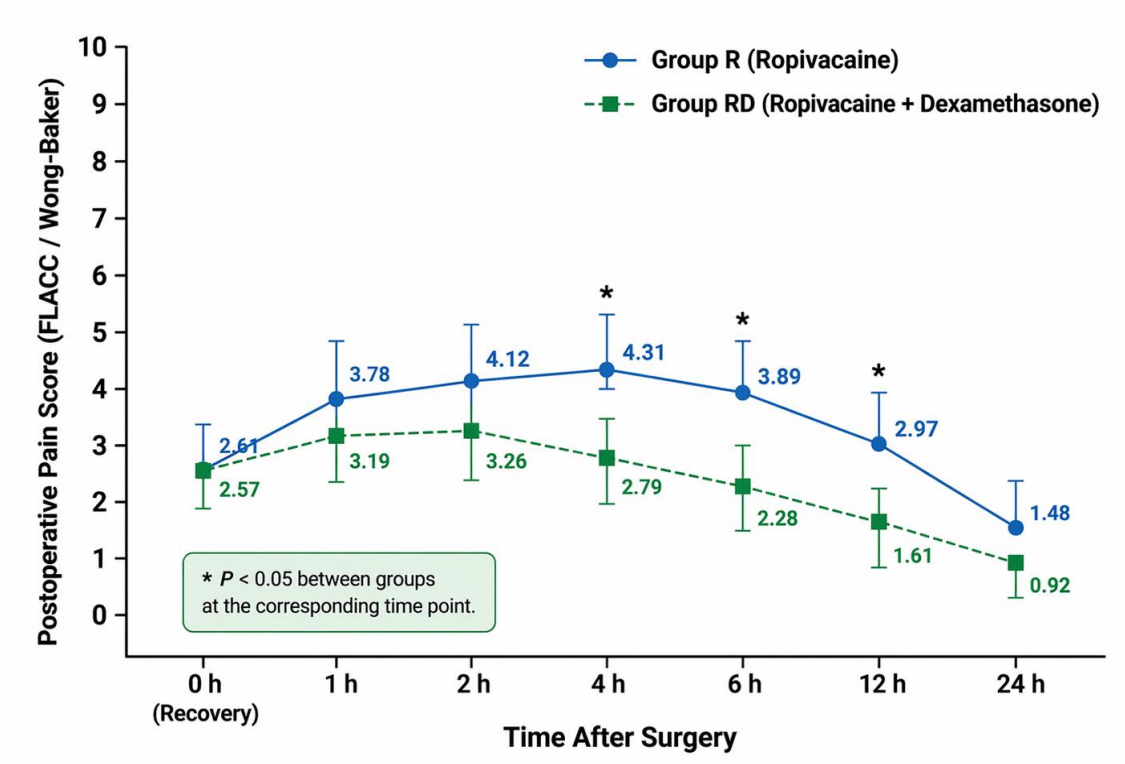



**Fig. 2.** Mean (± SD) postoperative pain scores at rest.

FLACC, Face, Legs, Activity, Cry, Consolability; Wong-Baker, Wong-Baker FACES Pain Rating Scale.

**Rescue Analgesic Consumption:** Total rescue analgesic consumption during the first 24 h was significantly reduced in Group RD. Mean paracetamol requirement was 286.7 ± 94.5 mg in Group R versus 173.3 ± 81.6 mg in Group RD (mean difference −113.4 mg, 95% CI −158.6 to −68.2; P <

0.001). Repeated rescue analgesia was required in 18 patients (60.0%) in Group R compared with 7 patients (23.3%) in Group RD (P = 0.004).

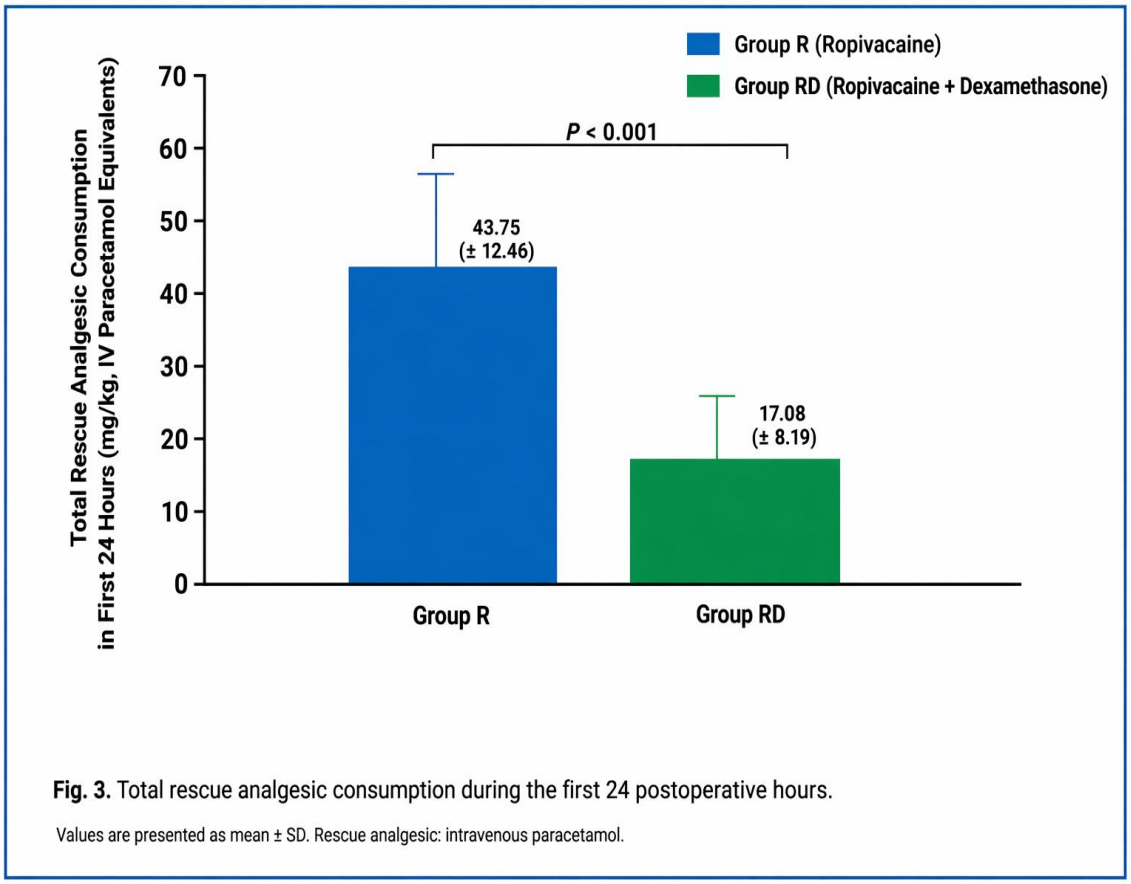



**Fig. 3.** Total rescue analgesic consumption during the first 24 postoperative hours.

Values are presented as mean ± SD. Rescue analgesic: intravenous paracetamol.

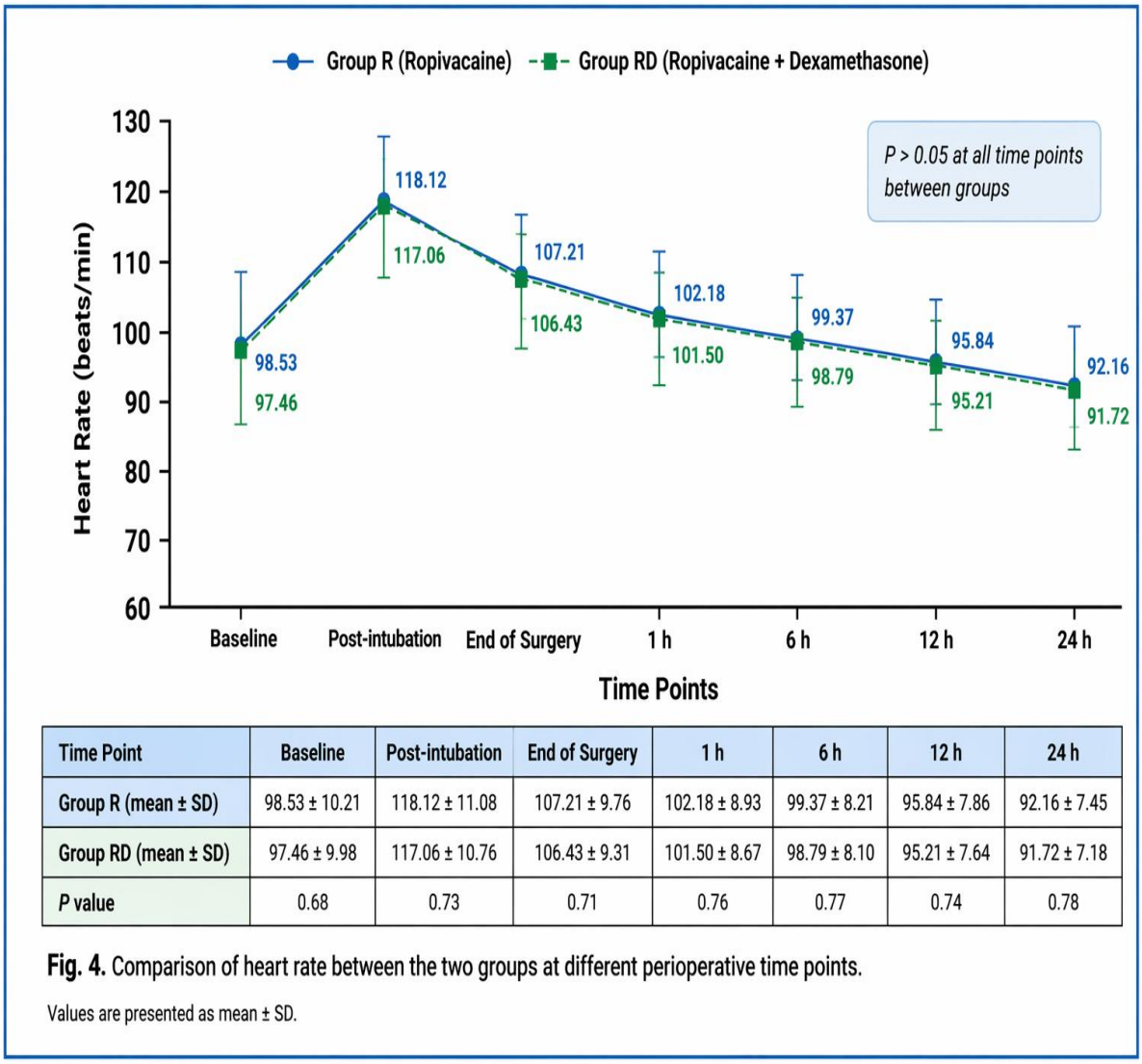
**Hemodynamic Variables:** Heart rate, mean arterial pressure, and peripheral oxygen saturation remained clinically stable in both groups throughout the study period. Baseline heart rate was 104.6 ± 12.8 beats/min in Group R and 102.9 ± 11.7 beats/min in Group RD (P = 0.589). Intraoperative mean arterial pressure at 30 min was 71.8 ± 6.4 mmHg and 70.9 ± 5.8 mmHg, respectively (P = 0.561). Peripheral oxygen saturation remained > 98% in all patients, with no significant intergroup differences at any time point (all P > 0.05) (Table 4).

Table 4. Perioperative Hemodynamic Variables and Adverse Events

| Variable | Group R N = 30 | Group RD N = 30 | P Value |
|---|---|---|---|
| Baseline heart rate (beats/min) | 104.6 ± 12.8 | 102.9 ± 11.7 | 0.589 |
| Mean arterial pressure at 30 min (mmHg) | 71.8 ± 6.4 | 70.9 ± 5.8 | 0.561 |
| Peripheral oxygen saturation (%) | > 98 in all patients | > 98 in all patients | > 0.05 |
| Postoperative nausea and vomiting, n (%) | 3 (10.0) | 2 (6.7) | 0.640 |
| Mild transient sedation, n (%) | 2 (6.7) | 1 (3.3) | 0.554 |

| | | | |
|---|---|---|---|
| Local anesthetic systemic toxicity, n (%) | 0 | 0 | — |
| Block-related complications, n (%) | 0 | 0 | — |

Values are presented as mean ± SD or number (%).




| Time Point | Baseline | Post-intubation | End of Surgery | 1 h | 6 h | 12 h | 24 h |
|---|---|---|---|---|---|---|---|
| Group R (mean ± SD) | 98.53 ± 10.21 | 118.12 ± 11.08 | 107.21 ± 9.76 | 102.18 ± 8.93 | 99.37 ± 8.21 | 95.84 ± 7.86 | 92.16 ± 7.45 |
| Group RD (mean ± SD) | 97.46 ± 9.98 | 117.06 ± 10.76 | 106.43 ± 9.31 | 101.50 ± 8.67 | 98.79 ± 8.10 | 95.21 ± 7.64 | 91.72 ± 7.18 |
| *P* value | 0.68 | 0.73 | 0.71 | 0.76 | 0.77 | 0.74 | 0.78 |

**Fig. 4.** Comparison of heart rate between the two groups at different perioperative time points.

Values are presented as mean ± SD.

**Adverse Events:** No serious adverse events, local anesthetic systemic toxicity, visceral injury, hematoma, infection, or block failure occurred in either group. Postoperative nausea and vomiting occurred in 3 patients (10.0%) in Group R and 2 patients (6.7%) in Group RD (P = 0.640). Mild transient sedation was observed in 2 patients (6.7%) in Group R and 1 patient (3.3%) in Group RD (P = 0.554). No patient required intensive postoperative intervention or unplanned hospital admission related to the study procedure.

## DISCUSSION

This study extends the available evidence by evaluating both analgesic efficacy and perioperative safety in a strictly pediatric surgical population. Although several previous studies have demonstrated benefits of dexamethasone in adult peripheral nerve and fascial plane blocks, pediatric data remain comparatively limited [5,6,18]. By focusing on children undergoing lower abdominal procedures, the present study provides clinically relevant evidence for a population in whom opioid-sparing analgesia is particularly desirable [1,4].

The most notable finding was the significant prolongation of postoperative analgesia with dexamethasone. The mean time to first rescue analgesia increased from 243.00 ± 97.36 min in the ropivacaine group to 525.85 ± 81.30 min in the dexamethasone group, representing an extension of more than 4.5 h. This result is consistent with previous randomized trials reporting prolonged block duration when dexamethasone was added to local anesthetics in TAP block and other regional techniques [8,9,17]. The proposed mechanisms include suppression of local inflammatory mediators, inhibition of nociceptive C-fiber transmission, membrane stabilization, and reduced vascular absorption of local anesthetics, thereby prolonging drug residence time at the target site [5,6].

In addition to prolonged analgesia, postoperative pain scores were significantly lower in the dexamethasone group at 4 h, 6 h, and 12 h after surgery. These time points correspond to the period during which single-shot TAP blocks commonly begin to regress [2,3]. The improved pain profile observed in the present study therefore suggests that dexamethasone not only extends block duration but also enhances the quality of postoperative analgesia during the early recovery phase [17,18].

Total rescue analgesic requirement during the first 24 h was significantly reduced in the dexamethasone group, and fewer patients required repeated rescue dosing. This finding is clinically important because reducing postoperative analgesic exposure may minimize drug-related adverse effects and improve recovery. In pediatric patients, limiting systemic analgesic use is particularly beneficial because children may be more susceptible to sedation, nausea, and respiratory depression associated with opioid therapy [1,4].

Hemodynamic variables remained stable and comparable between groups throughout the study period. No patient developed clinically significant bradycardia, hypotension, oxygen desaturation, local anesthetic systemic toxicity, or procedure-related complications. These findings support the safety of landmark-guided TAP block and suggest that the addition of dexamethasone did not adversely affect perioperative hemodynamic stability [3,4].

The favorable safety profile observed in this study is consistent with previous reports evaluating preservative-free dexamethasone as a regional anesthesia adjuvant. Although concerns have been raised regarding the perineural administration of adjunctive agents, contemporary evidence suggests that dexamethasone can be used safely when appropriate formulations and doses are selected [5,6,18]. Nevertheless, continued vigilance and long-term safety data remain important, particularly in children.

Several factors may explain the beneficial effects observed in this study. TAP block provides targeted somatic analgesia to the anterior abdominal wall, thereby reducing incisional pain after lower abdominal surgery [2,3]. When combined with a long-acting local anesthetic such as ropivacaine, dexamethasone appears to optimize both the duration and intensity of this analgesic effect [7,8,17]. Standardized landmark identification and consistent technique likely contributed to successful block performance.

This study has several limitations. First, it was conducted at a single center, which may limit generalizability. Second, although adequately powered for the primary outcome, the sample size may not have detected smaller differences in less frequent adverse events. Third, multiple lower abdominal procedures were included, and postoperative pain intensity may vary among surgical types. Fourth, pain assessment in pediatric patients may be influenced by age, communication ability, and observer interpretation despite use of validated scales. Fifth, serum concentrations of ropivacaine and mechanistic biomarkers were not measured. Finally, long-term recovery outcomes and patient-centered quality-of-recovery measures were not assessed.

## CONCLUSION

The addition of dexamethasone to ropivacaine in landmark-guided TAP block significantly prolonged postoperative analgesia, reduced pain scores, and decreased rescue analgesic requirements without increasing adverse events in pediatric patients undergoing lower abdominal surgery. These findings support the incorporation of dexamethasone as an effective adjunct in multimodal analgesia strategies for pediatric lower abdominal procedures. Further multicenter randomized trials are warranted to confirm these results and determine the optimal dose and route of dexamethasone administration [5,6,17,18].

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