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EFFECT OF ADDING DEXMEDETOMIDINE AS AN ADJUVANT TO ROPIVACAINE ON ANALGESIC EFFICACY OF TRANSVERSUS ABDOMINIS PLANE (TAP) BLOCK IN PATIENTS UNDERGOING GENERAL ANESTHESIA FOR PARAUMBILICAL HERNIA REPAIR

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Abstract

Background: *Paraumbilical hernia repair causes significant postoperative pain, often requiring opioids. TAP block reduces pain but has limited duration. Adding dexmedetomidine to ropivacaine may prolong analgesia; although evidence exists for other surgeries, data on umbilical hernia repair are limited, so this study compared both regimens for pain control and satisfaction.*

Objective: *To compare analgesic outcome of transversus abdominis plane block using dexmedetomidine as adjuvant to ropivacaine vs. ropivacaine alone in patients undergoing general anesthesia for paraumbilical hernia repair.*

Methods: *After ethical approval, 60 elective paraumbilical hernia patients were randomized into two groups. Group R received bilateral TAP block with ropivacaine 0.3% (20 ml each side), while Group RD received ropivacaine 0.3% plus dexmedetomidine 0.5 µg/kg. Pain, rescue analgesia, and satisfaction were assessed for 24 hours, with all procedures performed by a single anesthesiologist and analyzed using SPSS v17.*

Results: *Sixty patients were included with comparable demographics ($p>0.05$). Postoperative pain scores were significantly lower in Group RD at 1, 6, 12, and 24 hours ($p=0.001$, 0.005, 0.014, 0.001). Time to rescue analgesia was longer in Group RD (16.67±7.21 vs 8.06±6.27 hours; $p=0.004$), with higher patient satisfaction (96.7% vs 73.3%; $p=0.026$).*

Conclusion: *The addition of dexmedetomidine to ropivacaine for transversus abdominis plane block significantly improved postoperative analgesia in patients undergoing paraumbilical hernia repair. It resulted in lower pain scores, prolonged duration of analgesia, reduced need for rescue analgesics, and higher patient satisfaction, without adverse effects.*

INTRODUCTION

Paraumbilical hernia repair is a commonly performed abdominal surgical procedure, usually undertaken under general anesthesia.[1] Despite advances in surgical techniques and perioperative anesthetic care, postoperative pain remains a significant clinical challenge. Inadequate pain control may delay mobilization, prolong hospital

stay, increase healthcare costs, and negatively affect patient satisfaction and overall recovery.[2,3] Consequently, effective postoperative analgesia is an essential component of perioperative management. The transversus abdominis plane (TAP) block has gained widespread acceptance as part of multimodal analgesia for abdominal wall surgeries, including paraumbilical hernia repair. By targeting the sensory nerves of the anterior abdominal wall, TAP block provides effective pain relief while minimizing systemic opioid-related adverse effects.[4]

The TAP block was originally described by Rafi and McDonnell as a landmark-based "double-pop" technique, in which a blunt needle is advanced through the external and internal oblique muscles within the triangle of Petit.[4,5] This anatomical triangle is bounded posteriorly by the latissimus dorsi muscle, anteriorly by the external oblique muscle, and inferiorly by the iliac crest. The block anesthetizes the lower thoracic intercostal nerves (T7–T12) along with the iliohypogastric and ilioinguinal nerves as they course between the costal margin and iliac crest.[6,7] The introduction of ultrasound guidance has significantly improved the accuracy and safety of TAP block, allowing precise deposition of local anesthetic at various levels between the costal margin and iliac crest behind the anterior axillary line.[8]

Although TAP block has been shown to provide effective postoperative analgesia after abdominal surgery, its clinical usefulness is often limited by the relatively short duration of action of local anesthetics.[8] To overcome this limitation, several adjuvants, including fentanyl, dexamethasone, and clonidine, have been evaluated to prolong analgesic duration. More recently, dexmedetomidine, a highly selective α_2-adrenergic agonist, has attracted interest as an adjuvant due to its analgesic and opioid-sparing properties and its ability to enhance and prolong peripheral nerve blockade.[9,10]

Mangal et al. found that adding 1 µg/kg dexmedetomidine to 0.75% ropivacaine in a supraclavicular brachial plexus block significantly extended the duration of block (593.19 ± 114.44 min vs 704.8 ± 78.414 min; $P < 0.001$).[11] Pan et al. reported higher patient satisfaction with TAP block when dexmedetomidine was added, with 90.0% satisfaction in the RD group compared to 66.77% in the R group ($P = 0.028$).[12] However, Ding et al. found that TAP block with dexmedetomidine did not significantly improve recovery or block duration ($P > 0.05$).[13]

Despite TAP block's proven benefits, controversy persists because existing evidence is largely derived from heterogeneous abdominal surgeries, and data specific to paraumbilical hernia are limited. The variability in local anesthetic concentrations, adjuvants, and surgical pain patterns creates uncertainty about optimal dosing. This study addresses the gap by focusing on paraumbilical hernia repair, where postoperative pain is often moderate but under-studied, and seeks to clarify the best ropivacaine concentration and adjuvant strategy for effective, lasting analgesia.

METHODS

This randomized controlled trial was conducted in the Department of Anesthesia, Services Hospital, Lahore, over a period of 4 months w.e.f. 22-01-2025 to 21-05-2025 following the approval of the synopsis and ethical review committee. A sample size of 60 patients (30 in each group) was calculated with 80% power and 5% significance, based on expected mean durations of analgesia (5.93 ± 1.14 hours vs. 7.04 ± 1.78 hours) between the ropivacaine group and the ropivacaine-dexmedetomidine group. Non-probability consecutive sampling was used.[12] Patients aged 18 to 70 years, ASA I–II, scheduled for elective paraumbilical hernia repair under general anesthesia were included. Patients with contraindications to dexmedetomidine or ropivacaine, allergies to study drugs, neurological or psychiatric disorders, chronic opioid use, adverse reactions to regional anesthesia, significant hepatic/renal impairment, coagulopathy, pregnancy, breastfeeding, or inability to understand study procedures were excluded.

Operational definitions included pain score measured by Numerical Rating Scale (NRS) ranging from 0 (no pain) to 10 (worst pain), duration of analgesia defined as time from TAP block to first request for rescue analgesia when

NRS reached 4 or on patient demand, and patient satisfaction assessed by Likert scale at 24 hours and categorized as satisfied or unsatisfied. The hypothesis stated that there was a difference in analgesic efficacy between TAP block with ropivacaine and dexmedetomidine versus ropivacaine alone.

Eligible patients were counseled, and written informed consent was obtained. Patients were randomly assigned using the lottery method into two groups: Group R (ropivacaine 0.3% 20 mL per side) and Group RD (ropivacaine 0.3% 20 mL per side plus dexmedetomidine 0.5 µg/kg). Ultrasound-guided bilateral TAP block was performed immediately after surgery. The test group received ropivacaine 0.3% with dexmedetomidine diluted to a total volume of 40 mL normal saline, while the control group received ropivacaine 0.3% diluted to the same volume. After the block, patients were shifted to the postoperative recovery room for monitoring of vital signs, pain assessment, and adverse effects. Postoperative pain was assessed using NRS, and time to first pain reporting was recorded. Duration of analgesia was noted until the NRS reached 4, at which point IV tramadol 1 mg/kg was administered as rescue analgesia. Participation ended after rescue analgesia was given. Patient satisfaction was evaluated after 24 hours. All procedures were performed by a single anesthesiologist, and findings were recorded by the resident investigator to reduce bias. Confounding variables were controlled through exclusion criteria.

Data were entered and analyzed using SPSS version 17. Numerical variables such as age, BMI, duration of analgesia, and pain scores at baseline, 1, 6, 12, and 24 hours were presented as mean ± SD. Categorical variables such as ASA status, gender, and patient satisfaction were presented as frequency and percentage. Chi-square test was applied for satisfaction, and independent t-test was used for duration of analgesia and pain scores, considering $p \leq 0.05$ as significant. Data were stratified for age, gender, BMI, and ASA status, and post-stratification analysis was conducted using chi-square for satisfaction and t-test for duration of analgesia.

RESULTS

Table 1. Baseline Characteristics of Study Sample

Characteristics	Participants (n=60)
Age	42.67±14.01
• 18-45 years	35 (58.3%)
• 46-70 years	25 (41.7%)
Gender	
• Male	24 (40.0%)
• Female	36 (60.0%)
ASA Status	
• ASA-I	23 (38.3%)
• ASA-II	37 (61.7%)
BMI (kg/m^2)	25.87±3.05
• Male	86 (57.3%)
• Female	64 (42.7%)

A total of 60 patients undergoing paraumbilical hernia repair under general anesthesia were included in the study. The mean age of the participants was 42.67 ± 14.01 years, with 35 patients (58.3%) aged between 18–45 years and 25 patients (41.7%) between 46–70 years. The study population consisted of 24 males (40.0%) and 36 females (60.0%). Regarding physical status, 23 patients (38.3%) belonged to ASA class I, while 37 patients (61.7%) were classified as ASA class II. The mean body mass index (BMI) of the participants was 25.87 ± 3.05 kg/m², as given in Table 1.

Demographic variables, ASA status, and BMI were comparable between groups, with no statistically significant differences in age, gender distribution, ASA classification, or BMI (p>0.05) observed as shown in

Table 2. Comparison of Baseline Characteristics of between the Groups

Characteristics	Group R (n=30)	Group RD (n=30)	p-value
Age	43.13±14.19	42.20±14.07	0.799
• 18-45 years	16 (53.3%)	19 (63.3%)	0.432
• 46-70 years	14 (46.7%)	11 (36.7%)	
Gender			
• Male	13 (43.3%)	11 (36.7%)	0.598
• Female	17 (56.7%)	19 (63.3%)	
ASA Status			
• ASA-I	10 (33.3%)	13 (43.3%)	0.426
• ASA-II	20 (66.7%)	17 (56.7%)	
BMI (kg/m^2)	25.72±3.42	26.01±2.68	0.710
• Male	12 (40.0%)	9 (30.0%)	0.417
• Female	18 (60.0%)	21 (70.0%)	

Independent Sample t test /Chi-square test taking p-value ≤0.05 as significant*

Baseline pain scores were comparable between Group R and Group RD (1.43 ± 0.50 vs 1.50 ± 0.51; p=0.612). At 1 hour postoperatively, mean pain scores were significantly lower in Group RD (2.23 ± 0.43) compared to Group R (2.77 ± 0.73; p=0.001). At 6 hours, Group RD continued to show lower pain scores (2.33 ± 0.80 vs 2.90 ± 0.71; p=0.005). At 12 hours, pain scores were 1.80 ± 0.93 in Group RD and 2.47 ± 1.11 in Group R (p=0.014). At 24 hours, Group RD demonstrated significantly lower pain scores (1.70 ± 0.99) compared to Group R (2.43 ± 0.68; p=0.001). The mean time to rescue analgesia was significantly prolonged in Group RD (16.67 ± 7.21 hours) versus Group R (8.06 ± 6.27 hours; p=0.004). Data is given in

Table 3. Comparison of Mean Pain Score between the Groups at Different Intervals & Time to Rescue Analgesia

Interval / Parameter	Group R (Mean ± SD)	Group RD (Mean ± SD)	p-value
Pain Baseline	1.43 ± 0.50	1.50 ± 0.51	0.612
Post-op 1 hour	2.77 ± 0.73	2.23 ± 0.43	0.001
Post-op 6 hours	2.90 ± 0.71	2.33 ± 0.80	0.005
Post-op 12 hours	2.47 ± 1.11	1.80 ± 0.93	0.014
Post-op 24 hours	2.43 ± 0.68	1.70 ± 0.99	0.001
Time to Analgesia (hrs)	8.06 ± 6.27	16.67 ± 7.21	0.004

Independent Sample t test

The requirement for additional analgesia was higher in Group R, with 18 patients (60.0%) requiring rescue analgesia compared to 11 patients (36.0%) in Group RD; however, this difference did not reach statistical significance (p=0.071) which may however be associated with small sample size. Patient satisfaction with pain management was significantly greater in Group RD, where 29 patients (96.7%) reported satisfaction, compared to 22 patients (73.3%) in Group R (p=0.026), as shown in Table 4.0.

Moreover, study outcomes were stratified according to age, gender, BMI, and ASA status. Across all subgroups, Group RD consistently demonstrated better outcomes than Group R; however, statistical significance could not be achieved in all subgroups, likely due to the small sample size.

Table 4. Comparison of Patients Requiring Additional Medication (Analgesia) & Satisfaction

Description	Yes / No	Group R (n=30)	Group RD (n=30)	p-value
Need for Analgesia	Yes	18 (60.0%)	11 (36.0%)	0.071
	No	12 (40.0%)	19 (63.3%)	
Satisfaction on Pain Management	Yes	22 (73.3%)	29 (96.7%)	0.026
	No	8 (26.7%)	1 (3.3%)	

Chi Square test/Fisher's Exact test

DISCUSSION

Paraumbilical hernia repair is a common abdominal surgery associated with significant postoperative pain, which can delay recovery and increase opioid consumption.[1,3] Traditional analgesic approaches, including systemic opioids and local anesthetics, often provide limited duration of relief and carry side effects.[5,6] Transversus abdominis plane (TAP) block has emerged as an effective regional technique for reducing postoperative pain, but its analgesic effect may be short-lived when using local anesthetics alone.[7] Adding adjuvants such as dexmedetomidine to ropivacaine has been proposed to prolong analgesia and improve patient comfort, yet existing literature remains scarce regarding efficacy in paraumbilical hernia repair.[11,12] Therefore, this study evaluated the analgesic efficacy of TAP block using ropivacaine with and without dexmedetomidine in patients undergoing paraumbilical hernia repair, aiming to clarify its benefits and impact on postoperative pain and satisfaction.

The current study demonstrated that adding dexmedetomidine to ropivacaine for TAP block significantly reduced postoperative pain scores and prolonged time to first rescue analgesia in patients undergoing paraumbilical hernia repair. These findings align closely with several earlier studies examining the effect of dexmedetomidine as an adjuvant in abdominal wall blocks. For example, Sarvesh et al. reported a markedly longer duration of postoperative analgesia in the dexmedetomidine-ropivacaine group (485.6 minutes) compared with ropivacaine alone (289.83 minutes), along with significantly lower 24-hour morphine consumption (14.5 mg vs. 28.5 mg). Their conclusion that dexmedetomidine prolongs analgesia and reduces opioid requirement supports our observation of improved postoperative pain control and reduced analgesic demand.[14]

Khoshrang et al. also reported improved analgesic outcomes with dexmedetomidine added to local anesthetic. They observed significantly lower pain scores at 24 hours (T4) in the dexmedetomidine group and reduced pethidine consumption, although this reduction reached statistical significance only at T4. Similar to our study, they found no significant difference in postoperative nausea and vomiting between groups, suggesting that dexmedetomidine provides analgesic benefits without increasing common side effects. These results reinforce our conclusion that dexmedetomidine enhances TAP block efficacy while maintaining safety.[15]

In a randomized trial by Ding et al., both ropivacaine and ropivacaine-dexmedetomidine groups achieved significantly lower VAS pain scores and reduced PONV compared with saline controls. Although the differences between ropivacaine alone and ropivacaine-

dexmedetomidine were not statistically significant, the overall findings indicate that TAP block effectively reduces postoperative pain and nausea. This partially contrasts with our study, where dexmedetomidine produced a statistically superior analgesic effect compared with ropivacaine alone. The discrepancy may relate to differences in surgical procedures, drug concentrations, or sample size.[16]

Shabbir et al. evaluated dexmedetomidine as an adjunct to bupivacaine in TAP block for laparoscopic cholecystectomy and found significantly lower VAS scores at 4, 8, 12, and 24 hours in the dexmedetomidine group. They also showed that stratification by age, gender, ASA status, and surgery duration did not affect outcomes. This closely mirrors our study, where postoperative pain was consistently lower at all measured intervals, and stratified analyses similarly showed a trend favoring dexmedetomidine, although statistical significance was limited by sample size.[17]

Hussain et al. compared bupivacaine with and without dexmedetomidine in TAP block and reported significantly longer time to first analgesia (419.28 vs. 302.92 minutes) and reduced 24-hour opioid consumption in the dexmedetomidine group. Only one case of bradycardia occurred, indicating a favorable safety profile. These findings strongly correspond to our results, where time to rescue analgesia was significantly prolonged with dexmedetomidine, and additional analgesic requirement was reduced, confirming the opioid-sparing advantage of dexmedetomidine.[18]

Qian et al. studied dexmedetomidine-ropivacaine TAP block in cesarean section patients and observed prolonged pain-free duration, lower VAS scores, reduced rescue analgesia, and improved patient satisfaction without serious adverse effects. This aligns closely with our outcomes, where dexmedetomidine produced better pain relief and higher satisfaction rates. The consistency across different surgical procedures supports the generalizability of dexmedetomidine as a useful adjuvant for TAP blocks.[19]

Annand et al. compared ropivacaine alone versus ropivacaine with dexmedetomidine in TAP block and found a longer duration of analgesia, lower rescue analgesic requirements, and higher patient satisfaction in the dexmedetomidine group. They also reported significantly fewer adverse drug reactions and stable hemodynamics. These findings closely match our study, where patient satisfaction was significantly higher and no major adverse events were observed, reinforcing the benefit and safety of dexmedetomidine as an adjuvant.[20]

Theodoraki et al. similarly reported that dexmedetomidine added to ropivacaine reduced postoperative pain scores and demonstrated opioid-sparing effects in inguinal hernia repair, with no significant side effects. Their conclusion that dexmedetomidine provides favorable postoperative pain control supports our findings in paraumbilical hernia repair and suggests that the analgesic benefits of dexmedetomidine extend across hernia surgeries.[21]

Jan et al. conducted a randomized, double-blinded study in abdominoplasty patients and found significantly longer time to initial pain and first rescue analgesia in the dexmedetomidine group. They reported comparable block quality and side effects between groups, similar to our findings where dexmedetomidine improved analgesia without increasing complications. This adds further evidence that dexmedetomidine prolongs TAP block duration regardless of surgical type.[22]

Vishal et al. compared bupivacaine with and without dexmedetomidine in TAP block for cesarean section and reported significantly longer analgesia duration (24.39 vs. 15.43 hours), lower VAS scores at multiple time points, and reduced rescue analgesic use. Although patient satisfaction differences were not statistically significant, their overall findings strongly support dexmedetomidine's analgesic advantage, consistent with our study results.[23]

In contrast, Neethirajan et al. reported a shorter duration of analgesia and higher rescue analgesic requirement in the dexmedetomidine group compared with bupivacaine alone after laparoscopic appendicectomy, which contradicts most other studies. This inconsistency may be due to differences in dosing, block technique, or patient factors. Our study, like the majority of

literature, supports the beneficial effect of dexmedetomidine, suggesting that the observed divergence may be procedure-specific or related to methodological variations.[24]

Overall, the existing literature largely supports the conclusion of this study: dexmedetomidine added to ropivacaine in TAP block enhances postoperative analgesia, prolongs pain-free duration, reduces opioid consumption, and improves patient satisfaction without increasing adverse effects. While a few studies show mixed results, the weight of evidence supports the use of dexmedetomidine as a safe and effective adjuvant in TAP block for abdominal surgeries.

CONCLUSION

The addition of dexmedetomidine to ropivacaine for transversus abdominis plane block significantly improved postoperative analgesia in patients undergoing paraumbilical hernia repair. It resulted in lower pain scores, prolonged duration of analgesia, reduced need for rescue analgesics, and higher patient satisfaction, without adverse effects.

Authors Contribution

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Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

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Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

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