Archives of Anesthesiology and Critical Care (In Press); x(x): xx-xx.

Available online at http://aacc.tums.ac.ir

Research Article

Dexmedetomidine as an Adjuvant to Ropivacaine in Quadratus Lumborum Block for Patients Undergoing Laparoscopic Inguinal Hernia Repair: A Comparative Randomized Study

Karthik G. Sheshadri, Sudheer Ramegowda, Mahesh Chandra, Renjan R. I.*, Jasni K B, Harshith Ananth

Department of Anaesthesiology, Rajarajeswari Medical College and Hospital, Dr M.G.R. Educational and Reasearch Institute, Chennai, India.

ARTICLE INFO

Article history:
Received 27 October 2025
Revised 17 November 2025
Accepted 01 December 2025

Keywords:
Interfascial plane blocks;
Quadratus lumborum block;
Ultrasound-guided blocks;
Ropivacaine;
Dexmedetomidine;
Inguinal hernia;
Laparoscopic surgeries

ABSTRACT

Background: The Quadratus Lumborum Block (QL2) produces a broad distribution of local anesthesia, resulting in a large area of sensory inhibition from T7 to L1 in most cases. Therefore, QLBs are used to provide postoperative analgesia for abdominopelvic surgeries. Dexmedetomidine, an α_2-adrenergic agonist, possesses sedative, anxiolytic, hypnotic, analgesic, and sympatholytic properties. In this study, we aimed to determine the analgesic efficacy of dexmedetomidine as an adjuvant to ropivacaine in the quadratus lumborum block for patients undergoing laparoscopic inguinal hernia repair.

Methods: A total of 70 patients belonging to ASA grades I and II and aged between 30 and 60 years scheduled for elective laparoscopic inguinal hernia repair were randomly assigned into two groups. Group I received 0.375% plain ropivacaine, and Group II received 0.375% ropivacaine along with 100 mcg of dexmedetomidine after induction of general anesthesia through QL2. The primary outcome was to compare the time to first rescue analgesic between the two groups. Other secondary outcomes observed were VAS for 24 hours postoperatively, total number of rescue analgesia doses, and adverse effects, if any.

Results: Both groups were statistically comparable for demographic variables, ASA physical status grading, and duration of surgery. The time to the first rescue analgesic request was significantly prolonged in Group II compared to Group I ($p < 0.001$). The mean VAS scores and total rescue analgesic requirements were higher in Group I, indicating superior analgesic efficacy in Group II.

Conclusion: The addition of dexmedetomidine to ropivacaine in a quadratus lumborum block significantly prolonged the duration of analgesia compared with ropivacaine alone.

Introduction

Laparoscopic inguinal hernia repair has become an acceptable option for the repair of an inguinal hernia. Potential benefits of the laparoscopic approach include quicker postoperative recovery and possible decreased incidence of long-term pain with similar recurrence rates as compared to the open approach [1-3].

Quadratus lumborum block (QL2) produces a wide distribution of local anesthesia, resulting in a larger area

The authors declare no conflicts of interest.
*Corresponding author.
E-mail address: drrenjanri@gmail.com
DOI:

of sensory inhibition. Therefore, QLBs may be employed to provide postoperative analgesia for abdominal and pelvic areas. Owing to these characteristics, it is widely used for pain management following various intra-abdominal, obstetric, gynecologic, and urologic procedures. Additionally, QLB offers several advantages, including superior analgesic efficacy, opioid-sparing effects, and improved management of visceral pain [2-7].

Ropivacaine is a long-acting amide-type local anesthetic that was first developed as the pure S (–) enantiomer. Its pharmacological action is mediated through the reversible inhibition of voltage-gated sodium ion influx in neuronal membranes, thereby preventing the initiation and propagation of nerve impulses. Ropivacaine exhibits lower lipophilicity compared with bupivacaine, which reduces its ability to penetrate large myelinated motor fibers. As a result, it produces a less intense motor blockade while maintaining effective sensory anesthesia. This characteristic enhances sensory-motor differentiation, rendering ropivacaine especially beneficial in clinical contexts where the maintenance of motor function is essential. Furthermore, its reduced lipophilicity contributes to a lower propensity for cardiovascular and central nervous system toxicity, enhancing its overall safety profile relative to other long-acting local anesthetics [8-9].

Dexmedetomidine is a selective α_2-adrenergic receptor agonist that exhibits sedative, anxiolytic, hypnotic, analgesic, and sympatholytic properties. These effects are mediated through the inhibition of central sympathetic outflow via activation of α_2-receptors in the brainstem, which suppresses the release of norepinephrine. The precise mechanism by which dexmedetomidine prolongs the duration of peripheral nerve blocks remains incompletely understood. However, current evidence suggests that this effect is primarily mediated through a perineural instead of a systemic or central pathway, which may involve the modulation of cation currents that contribute to nerve excitability [10-12].

Methods

This prospective, randomized study was conducted after approval from the Institutional Ethics Committee (vide letter no: IEC/334/2024) and registered in the Clinical Trial Registry of India. The study spanned from October 2024 to June 2025 and aimed to evaluate the efficacy of dexmedetomidine as an adjuvant to 0.375% ropivacaine in the quadratus lumborum block for patients undergoing laparoscopic unilateral inguinal hernia repair. The primary outcome measured was the time to first rescue analgesic request. Secondary outcomes included Visual Analogue Scale (VAS) scores, cumulative rescue analgesic consumption in the first 24 hours postoperatively, and the incidence of adverse effects. Written informed consent was obtained from all the patients. Based on a study conducted by G. Dilip Kumar et al. [13], considering the time to first rescue analgesia requirement as a primary objective with a type 1 alpha error of 0.05 and the power of the study being 80%, we derived the sample size of 70 (35 in each group). A total of 70 patients, aged between 30 and 60 years, planned for laparoscopic unilateral inguinal hernia repair and classified as American Society of Anesthesiologists (ASA) physical status I or II, were enrolled. Exclusion criteria included hypersensitivity to local anesthetics, bleeding disorders, epilepsy, severe hepatic or renal disease, uncontrolled diabetes mellitus, and unwillingness to participate.

The study was performed in accordance with the ethical standards of the Institutional Ethics Committee and the principles of the Declaration of Helsinki (2013 revision). A detailed pre-anesthetic evaluation was performed in all patients. They were thoroughly informed about the surgical procedure and educated on the use of the Visual Analog Scale (VAS) for pain assessment, where 0 indicates no pain and 10 represents the worst imaginable pain. Standard preoperative fasting guidelines were observed, with all patients kept nil per oral for at least six hours before surgery. Oral alprazolam (0.25 mg) and pantoprazole (40 mg) were administered as premedication on the night prior to surgery.

Upon arrival in the operating theatre, standard American Society of Anesthesiologists (ASA) monitoring was instituted. Baseline physiological parameters, including heart rate, non-invasive blood pressure (NIBP), oxygen saturation (SpO_2), respiratory rate, and electrocardiographic (ECG) readings, were recorded. An 18-gauge intravenous cannula was secured under aseptic precautions, and intravenous fluid therapy was initiated in accordance with patient requirements.

Patients were randomly assigned to two groups using the sealed opaque envelope method. Group I received 20 mL of 0.375% ropivacaine with 1 mL of sterile normal saline, administered bilaterally, whereas Group II received 20 mL of 0.375% ropivacaine with 100 µg of dexmedetomidine reconstituted to a volume of 1 mL, administered bilaterally.

Following adequate preoxygenation in the supine position, patients were premedicated with IV midazolam 0.01 mg/kg, glycopyrrolate 0.2 mg, and fentanyl 1–2 µg/kg. Induction was carried out using IV propofol 2 mg/kg, and muscle relaxation was achieved with IV vecuronium 0.1 mg/kg. After confirming adequate neuromuscular blockade, endotracheal intubation was performed, bilateral air entry verified, and the tube secured. Anesthesia was maintained using an oxygen–air mixture with sevoflurane and intermittent doses of vecuronium. Following induction, a bilateral quadratus lumborum (QL2) block was performed with the patient in the lateral position using a curvilinear ultrasound probe. The ultrasound probe was positioned transversely along

the posterior axillary line, superior to the iliac crest, at the level of the L4 vertebra. Anatomical landmarks, including the L4 transverse process, psoas major muscle, and quadratus lumborum muscle, were identified. Under real-time ultrasound guidance, a 23-gauge spinal needle (10 cm) was advanced using an in-plane approach (Figure 1). The study drug, as per group allocation, was then injected bilaterally into the fascial plane between the psoas major and quadratus lumborum muscles.

Vital parameters were monitored continuously and recorded at regular intervals throughout the surgical procedure. At the conclusion of surgery, residual neuromuscular blockade was antagonized with intravenous (IV) neostigmine 50 µg/kg and glycopyrrolate 10 µg/kg. Following adequate reversal and the return of spontaneous respiration, patients were extubated and transferred to the post-anesthesia care unit (PACU) for further monitoring (Figures 3, 4 and 5). Postoperative pain intensity was evaluated at predetermined intervals using the Visual Analog Scale (VAS). Patients who reported a VAS score of 4 or higher received intravenous (IV) paracetamol 1g as rescue analgesia.

The two groups were compared with respect to the time to first rescue analgesic administration, which was designated as the primary outcome measure. The time to first rescue analgesic was defined as the interval between completion of the block and administration of rescue analgesia, given when the patient reported pain corresponding to a VAS score greater than 4. Secondary outcome measures included Visual Analog Scale (VAS) scores at specified postoperative intervals, the total dose of analgesic required during the first 24 hours, and the incidence of adverse effects like postoperative nausea and vomiting, motor weakness, and local anesthetic systemic toxicity. (Figure 2) illustrates the CONSORT flow diagram, detailing the screening, randomization, and inclusion of patients in the study.

Data were compiled in Microsoft Excel and analyzed using SPSS version 22, Epi Info version 7.2.1, and Jamovi version 2.6.26.0. Categorical data were expressed as frequencies and percentages and compared using the chi-square test. Continuous data were presented as mean ± SD; normality was assessed by the Kolmogorov–Smirnov and Shapiro–Wilk tests.

The independent t-test or Mann–Whitney U test was applied as appropriate. A P value < 0.05 was considered statistically significant, and a P value < 0.001 was considered highly significant.

Results

A total of seventy patients were enrolled in the study and randomly assigned to two groups. Group I received 20 mL of 0.375% ropivacaine combined with 1 mL of normal saline, whereas Group II received 20 mL of 0.375% ropivacaine with 100 µg of dexmedetomidine, diluted to a total volume of 1 mL, as an adjuvant. No patients were omitted from the study. Both groups were comparable with respect to demographic characteristics, including age, sex, weight, height, ASA physical status, and duration of surgery (Table 1).

The time to first rescue analgesic was significantly longer in Group II (960.42 ± 10.26 minutes) compared with Group I (640.68 ± 30.42 minutes) ($p < 0.001$) (Table 2).

Similarly, the total postoperative rescue analgesic requirement was higher in Group I (2.8 ± 0.21) than in Group II (1.2 ± 0.11) ($p < 0.001$) (Table 2). Postoperative VAS scores were consistently lower in Group II at all assessed time points, indicating superior analgesic efficacy ($p < 0.05$) (Table 3).

No signs of local anesthetic systemic toxicity were observed in either group. Furthermore, no significant hemodynamic instability or other adverse effects occurred during the intraoperative or postoperative periods (Table 4).

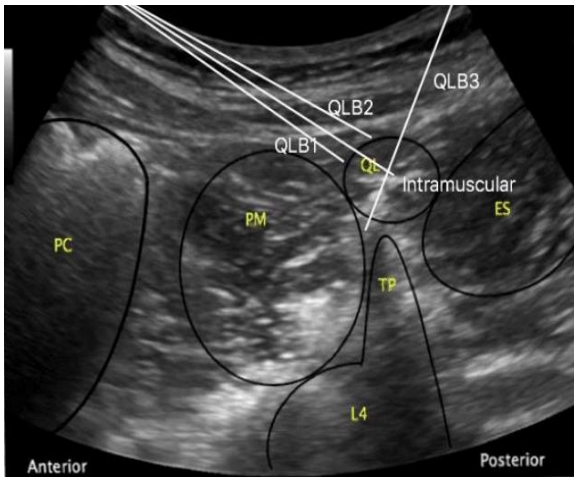

Figure 1- USG image of Quadratus Lumborum blocks with arrows showing needle directions. QL – Quadratus lumborum, PM – Psoas Major, ES – Erector Spinae, PC – Peritoneal Cavity, TP – Transverse Process, L4 – Fourth Lumbar Vertebra

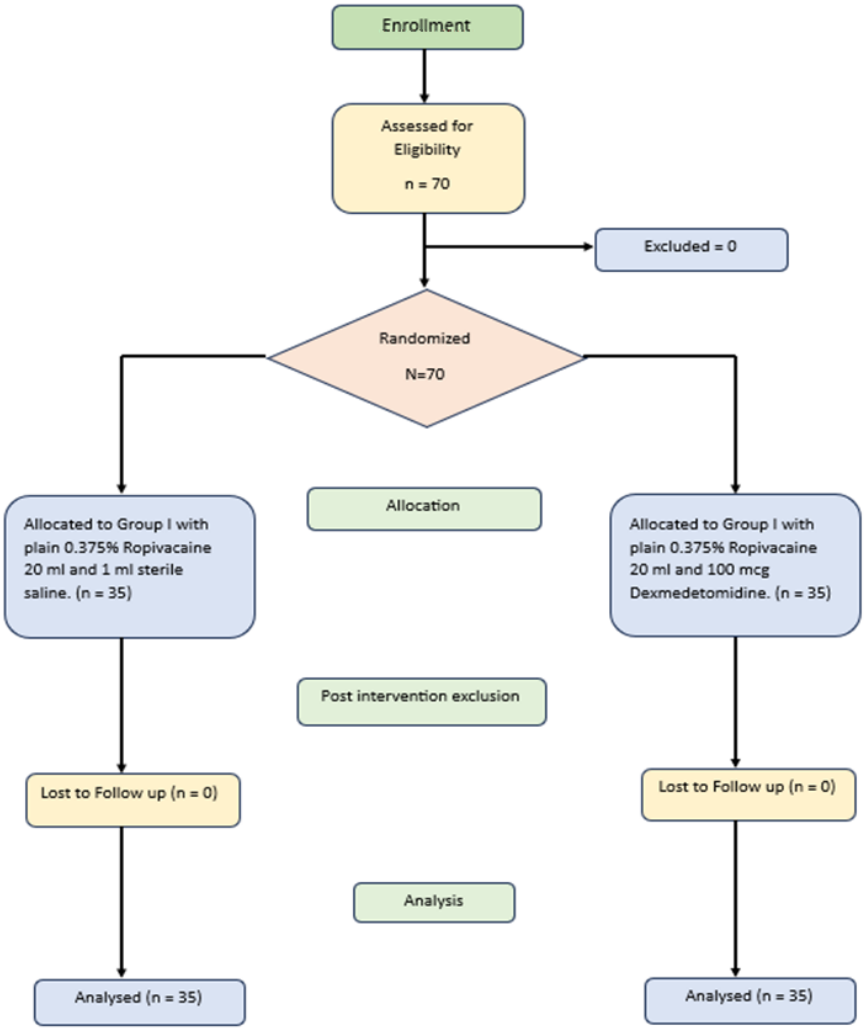

Figure 2- Consort Flow Diagram

Table 1- Demographic profile of subjects and duration of surgery in two groups

Parameters	Group I	Group II	P value
Age	41.6 ± 5.2	43.5 ± 2.4	0.68
Weight	65.6 ± 3.2	64.4 ± 4.7	0.23
Height	169.14 ± 2.6	171.2 ± 3.4	0.56
ASA Grade I/II	16/19	14/21	0.16
Duration of Surgery	160 ± 11.6	164 ± 7.9	0.426

Table 2- Time to first rescue analgesic and total dose of rescue analgesic comparison between two groups

Variable	Group I	Group II	P value
Time to first rescue analgesia (minutes)	640.68 ± 30.42	960.42 ± 10.26	<0.001*
Total doses of rescue analgesic used (1 g PCT IV)	2.8 ± 0.21	1.2 ± 0.11	0.0036*

Table 3- VAS Score comparison between two groups at different periods of follow-up

VAS score (hrs)	Group I	Group II	P value
0	2.6 ± 1.2	2.5 ± 0.3	0.14
4	2.9 ± 0.97	3.0 ± 0.56	0.36
8	3.1 ± 0.46	3.2 ± 0.18	0.51
12	7.2 ± 1.8	3.6 ± 0.96	0.0016*
24	6.8 ± 1.2	5.6 ± 0.68	0.042*

Table 4- Adverse Effects comparison between two groups

Adverse effects	Group I	Group II
Local site tenderness and hematoma	NIL	NIL
Local Anesthetic Systemic Toxicity	NIL	NIL
Nausea and vomiting	NIL	NIL
Lower Limb Weakness	NIL	NIL

P value > 0.05, insignificant

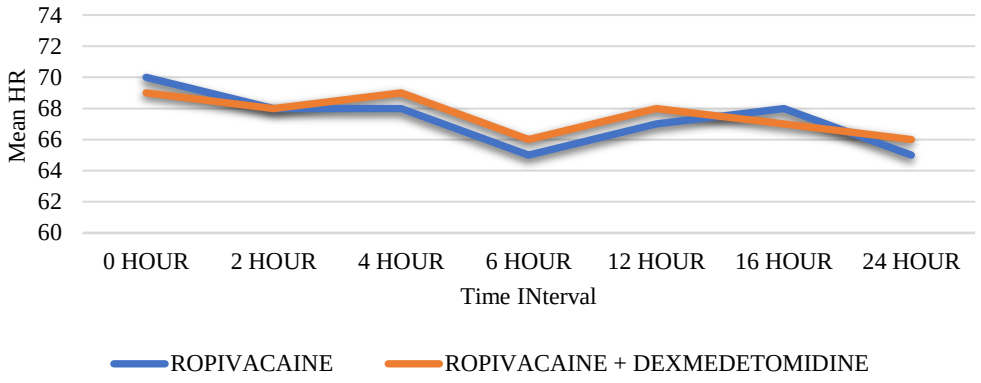

Figure 3- Mean Heart Rate Comparison

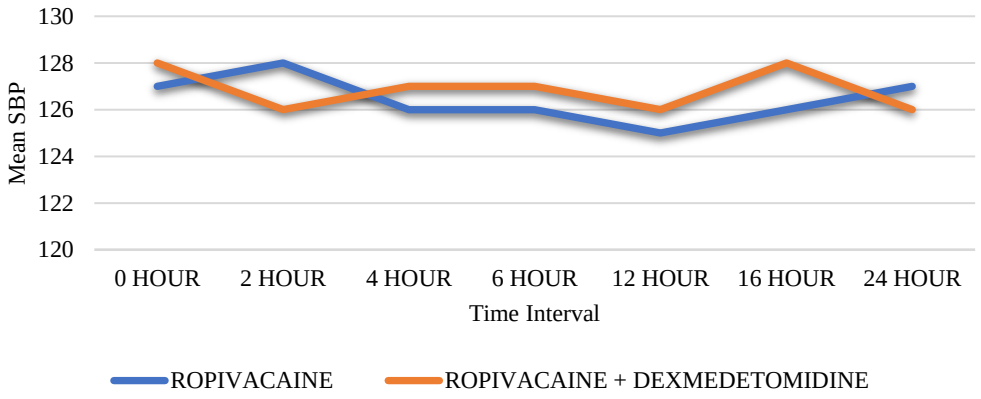

Figure 4- Mean Systolic Blood Pressure Comparison

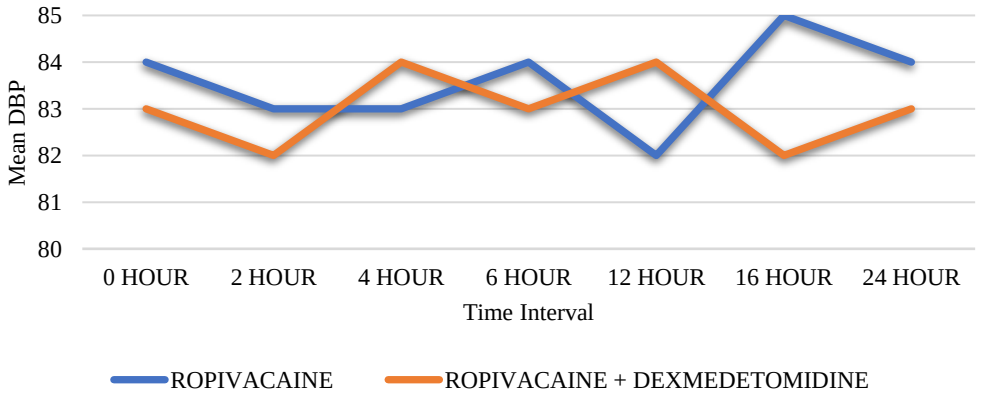

Figure 5- Mean Diastolic Blood Pressure Comparison

Discussion

Quadratus lumborum block (QL2) provides analgesia for the anterior and lateral abdominal wall. It is an interfascial plane block, as it requires injection of local anesthetics into the thoracolumbar fascia. Nociceptors, sympathetic fibers, and mechanoreceptors are inhibited. Though different variants have been described, QL2 refers to injection posterior to the quadratus lumborum muscle. These blocks provide effective postoperative analgesia for the abdomino-pelvic region and are commonly employed following abdominal, urological, and obstetric surgeries. Additionally, they have been utilized in hip, femur, and lumbar spine surgeries.

In this randomized study, we compared plain ropivacaine with ropivacaine combined with dexmedetomidine for postoperative analgesia in patients undergoing laparoscopic inguinal hernia repair. Ropivacaine was selected due to its favorable safety profile, being neither cardiotoxic nor neurotoxic. To our knowledge, no studies have evaluated the use of 0.375% ropivacaine with 100 µg dexmedetomidine in this setting, which prompted our investigation. The combination of ropivacaine and dexmedetomidine resulted in a significantly prolonged duration of analgesia and reduced total rescue analgesic requirements, as reflected by lower VAS scores. No adverse effects were observed in either group.

Dexmedetomidine, a highly selective α_2-adrenergic receptor agonist, is extensively employed as an adjuvant in peripheral nerve blocks, attributable to its sedative, analgesic, anxiolytic, and sympatholytic effects, which contribute to enhanced perioperative analgesia and improved patient outcomes. It also accelerates the onset of anesthesia and extends the duration of sensory and motor blockade. In a study conducted by Ahmed El Sakka et al. [15], they selected 50 patients who underwent lower segment caesarean section under spinal anesthesia. The total amount of morphine used in the first 24 hours was decreased in the group that received a combination of bupivacaine and dexmedetomidine.

They also did not notice any side effects, and hence they concluded that dexmedetomidine is a useful adjuvant to bupivacaine in the quadratus lumborum block in patients who underwent lower segment cesarean section under spinal anesthesia for postoperative analgesia.

S. Vaghela et al. [16] also opined that dexmedetomidine added to ropivacaine prolonged the duration of postoperative analgesia during laparoscopic appendectomy and hernia repair, which was in accordance with our study.

In this study, no rescue analgesia was required in the group that received dexmedetomidine as an adjuvant to ropivacaine.

In a study by Kassiani Theodoraki et al. [17], the analgesic efficacy of dexmedetomidine as an adjuvant to local anesthetic in TAP block was evaluated. The primary outcome was the Numeric Rating Scale (NRS) score during postoperative coughing. The authors reported that the addition of dexmedetomidine to ropivacaine reduced NRS scores, demonstrated opioid-sparing effects, and provided a favorable profile for postoperative pain management following inguinal hernia repair.

The beneficial effects of dexmedetomidine as an adjuvant to ropivacaine have also been evaluated in older adults undergoing open inguinal hernia repair by Xiaokun Zhang et al. [18].

They reported that the addition of dexmedetomidine to ropivacaine in TAP blocks improved the quality of postoperative analgesia without causing adverse hemodynamic effects, findings that are consistent with the results of our study.

Our study had few limitations. Only patients belonging to ASA I and II were selected. In the future, a large sample size would be feasible to obtain valid observations and interpretations to substantiate our findings using various drug regimens.

Conclusion

Our study demonstrated that the addition of dexmedetomidine to ropivacaine for the quadratus lumborum block in patients undergoing laparoscopic inguinal hernia repair delayed the request for the first rescue analgesic significantly compared to plain ropivacaine. The total amount of rescue analgesic was also markedly less in the first 24 hours when dexmedetomidine was used without any significant adverse effects, and thus we consider dexmedetomidine as a useful adjuvant for local anesthetics in interfascial plane blocks.

References

[1] Hope WW, Pfeifer C. Laparoscopic Inguinal Hernia Repair. 2023 Jul 3. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan–.

[2] Korgvee A, Junttila E, Koskinen H, Huhtala H, Kalliomaki ML. Ultrasound-guided quadratus lumborum block for postoperative analgesia: A systematic review and meta-analysis. Eur J Anaesthesiol. 2021; 38(2):115-29.

[3] Anjum W, Rehman A, Saleem A, Anjum MA, Hussain S, Abrar M. Quadratus lumborum block in laparoscopic inguinal hernia repair: A single center study. Prof Med J. 2024; 31(04):509-13.

[4] Gupta A, Sondekoppam R, Kalagara H. Quadratus lumborum block: a technical review. Curr Anesthesiol Rep. 2019; 9(3):257-62.

[5] Dhanjal ST, Tonder S. Quadratus Lumborum Block. [Updated 2023 Aug 14]. In: StatPearls [Internet].

Treasure Island (FL): StatPearls Publishing; 2025.
[6] Long X, Yin Y, Guo W, Tang L. Ultrasound-guided quadratus lumborum block: a powerful way for reducing postoperative pain. Ann Med Surg (Lond). 2023; 85(10):4947-53.
[7] Makhni R, Attri JP, Kaur H, Markam KK. Comparison of ultrasound-guided transversus abdominis plane (TAP) block and quadratus lumborum (QL) block in inguinal hernia surgery. Indian J Anaesth. 2022; 66(Suppl 2):S122-S125.
[8] Patel P, George AM, Liu M. Ropivacaine. 2025 Apr 26. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan–.
[9] Liu QR, Dai YC, Xie J, Li X, Sun XB, Sun J. Ultrasound-Guided Quadratus Lumborum Block Enhances the Quality of Recovery after Gastrointestinal Surgery: A Randomized Controlled Trial. Pain Res Manag. 2022; 2022:8994297.
[10] Murouchi T, Iwasaki S, Yamakage M. Quadratus Lumborum Block: Analgesic Effects and Chronological Ropivacaine Concentrations After Laparoscopic Surgery. Reg Anesth Pain Med. 2016; 41(2):146-50.
[11] Weerink MAS, Struys MMRF, Hannivoort LN, Barends CRM, Absalom AR, Colin P. Clinical Pharmacokinetics and Pharmacodynamics of Dexmedetomidine. Clin Pharmacokinet. 2017; 56(8):893-913.
[12] Andersen JH, Grevstad U, Siegel H, Dahl JB, Mathiesen O, Jæger P. Does Dexmedetomidine Have a Perineural Mechanism of Action When Used as an Adjuvant to Ropivacaine? : A Paired, Blinded, Randomized Trial in Healthy Volunteers. Anesthesiology. 2017; 126(1):66-73.
[13] Chen Z, Liu Z, Feng C, Jin Y, Zhao X. Dexmedetomidine as an Adjuvant in Peripheral Nerve Block. Drug Des Devel Ther. 2023; 17:1463-84.
[14] Kumar GD, Gnanasekar N, Kurhekar P, Prasad TK. A Comparative Study of Transversus Abdominis Plane Block versus Quadratus Lumborum Block for Postoperative Analgesia following Lower Abdominal Surgeries: A Prospective Double-blinded Study. Anesth Essays Res. 2018; 12(4):919-23.
[15] El-Sakka AI, El-Refai NA, ElAraby MS, Abd El-Halim RA, Youssef MI, Hammad YM. Evaluation of the analgesic efficacy of dexmedetomidine as an adjuvant to local anesthesia in quadratus lumborum block after cesarean section: A randomized controlled trial. Egypt J Anaesth. 2023; 39(1):929-35.
[16] Vaghela SS, Chaurasiya MK, Prakash R, Khan MP. Ultrasound-guided quadratus lumborum block versus transversus abdominis plane block for laparoscopic inguinal hernia repair and appendicectomy using ropivacaine with dexmedetomidine. Cureus. 2023; 15(1).
[17] Theodoraki K, Koutalas I, Orfanou C. Evaluation of the Adjuvant Effect of Dexmedetomidine on Ropivacaine for Transversus Abdominis Plane Block in Inguinal Hernia Repair: A Prospective Double-Blind Randomized Trial. J Clin Med. 2025; 14(7):2478.
[18] Zhang X, Zhang J, Gu W, Wu D, Shi C, Ma Z. Dexmedetomidine adjunct to ropivacaine for ultrasound-guided transversus abdominis plane block for open inguinal hernia repair in the older adults: A randomised clinical trial. J Minim Access Surg. 2024; 20(2):187-95.