Original Article

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Comparison of the Postoperative Analgesic Efficacy of Adjuvant Anterior Quadratus Lumborum Block in Laparoscopic Cholecystectomies: A Prospective Randomized Double-blind Study

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Abstract

Aim: The quadratus lumborum block (QLB) is frequently used for postoperative pain relief in laparoscopic cholecystectomies (LC). When added as an adjuvant to local anesthetics, dexamethasone may improve and extend the analgesic effect. This prospective study aimed to assess the efficacy of dexamethasone as an adjuvant in anterior QLB for LC.

Methods: Eighty-three patients undergoing LC were randomly assigned to two groups. Group anterior (A)-QLB (n=39) received bilateral anterior QLB with 20 mL of 0.25% bupivacaine plus 4 mg of dexamethasone. Group QLB (n=44) received the same volume and concentration of bupivacaine without dexamethasone. Dermatomal spread was evaluated after the block. Intraoperative remifentanil consumption, 24-hour postoperative tramadol use, time to first rescue analgesic, numeric rating scale (NRS) pain scores, and side effects were recorded.

Results: Total tramadol consumption within the first 24 postoperative hours was comparable between the groups. However, NRS scores at 4, 8, 12, and 24 hours were significantly lower in the A-QLB group. Dermatomal spread was broader in the A-QLB group. No significant differences were observed between the groups regarding the time to first rescue analgesic and intraoperative remifentanil consumption.

Conclusion: In LC, anterior QLB used for postoperative pain relief showed that patients receiving dexamethasone with local anesthetic via the interfascial route had lower postoperative NRS scores and broader dermatomal spread compared to those receiving only local anesthetic, indicating that interfascial dexamethasone provides superior analgesic effects.

Keywords: Adjuvant, dexamethasone, postoperative analgesia, laparoscopic cholecystectomy

Introduction

Among surgical interventions, laparoscopic cholecystectomy (LC) ranks as one of the most frequently conducted procedures. The pain intensity following LC is typically lower than in open procedures, but patients may still report moderate to severe levels. This pain can originate from somatic nerves at the trocar entry sites, visceral discomfort due to gallbladder manipulation, or visceral discomfort caused by CO_2 insufflation of the abdomen (1).

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Postoperative analgesia often requires the use of opioid analgesics. However, due to undesirable side effects—such as nausea, vomiting, itching, dependency, and prolonged hospital stays—the use of truncal blocks as part of multimodal analgesia has increased in recent years (2,3). Quadratus lumborum blocks (QLB) are among the techniques used for postoperative analgesia in abdominal surgical procedures. Studies have shown that analgesia can be achieved in the T7-L2 dermatomal regions (4).

Dexamethasone is a glucocorticoid known for its ability to prolong the effects of local anesthetics and suppress inflammation when used as an adjuvant (5,6). Its efficacy in pain management has been shown in caudal, brachial plexus, epidural, and perineural blocks without associated adverse effects (7,8). The exact mechanism is not fully understood, but several pathways have been proposed. Glucocorticoids have been reported to produce a membrane-stabilizing effect on nerve cells, similar to local anesthetics; this effect reduces nerve conduction. In addition, they suppress proinflammatory transcription factors such as nuclear factor kappa B (NF-κB) at the spinal level, thus inhibiting central sensitization (9,10). These properties make dexamethasone a safe and effective adjuvant for enhancing postoperative analgesia.

We hypothesized that using perineural (interfascial) dexamethasone as an adjuvant in the anterior QLB, would improve postoperative analgesic efficacy compared to local anesthetics without adjuvants in LC cases. We also considered that analyzing dermatomal spread in the adjuvant QLB group would offer important information regarding dexamethasone's contribution to overall analgesic efficacy.

This study aimed to determine whether the addition of dexamethasone to local anesthetics in the interfascial plane of the anterior QLB improves postoperative analgesia in patients undergoing LC. Specifically, we assessed total tramadol consumption within the first 24 hours postoperatively, numeric rating scale (NRS) scores (at rest and during movement), intraoperative remifentanil consumption, time to first rescue analgesic administration, dermatomal spread, and adverse effects. By analyzing these outcomes, this study aims to clarify the impact of dexamethasone on multimodal analgesia strategies, particularly regarding opioid consumption and postoperative pain management. Given its anti-inflammatory and analgesic-prolonging effects, dexamethasone may enhance these outcomes as an adjuvant in the interfascial plane.

Materials and Methods

Compliance with Ethical Standards

Ethical approval was obtained from the University of Health Sciences Türkiye, Gaziosmanpasa Training and Research Hospital Clinical Research Ethics Committee under the registration number (approval no.: 40, date: 10.05.2023). The study was registered in the Clinical Trials database with the number NCT06028061.

The study was conducted at the general surgery OR of University of Health Sciences Türkiye, Gaziosmanpasa Training and Research Hospital between September 1, 2023, and February 15, 2024. It adhered to the Declaration of Helsinki. Only patients who gave signed informed consent prior to participation were included.

Study Design and Patients

The present research was double-blind, randomized, and prospective. Participants were American Society of Anesthesiologists (ASA) class I-II patients, aged 18-65, scheduled for elective LC. Exclusion criteria were infection at the block site, previous abdominal surgery, allergy to local anesthetics, coagulation disorders, chronic analgesic or opioid use, neurological or psychological disorders, communication difficulties, body mass index >35 kg/m², absent dermatomal involvement at 30 minutes, non-adherence to the analgesia protocol, major perioperative complications, or operative time over 90 minutes.

Grouping and Randomization

A computer-based system created the randomization list. This list was placed in sealed envelopes labeled with sequential numbers. Group allocation was determined by opening the next envelope for each patient. Participants were divided into two groups: Group A-QLB (adjuvant) and Group QLB (non-adjuvant).

Block Procedure

The local anesthetic solutions were prepared by a blinded anesthetist who was not involved in either block administration or patient follow-up. All block procedures were performed by the same experienced anesthesiologist, who was also blinded to the prepared medication. The patients were blinded as well. All blocks were administered 30 minutes prior to surgery.

The block procedures were performed after standard monitoring was established, with the patients placed in the lateral position and appropriate aseptic conditions ensured. A convex ultrasound (USG) probe (2-6 MHz) (MyLabseven; Esaote Europe, Netherlands) was used. The probe was positioned in the subcostal area, above the iliac crest, and along the mid-axillary line to visualize the quadratus lumborum muscle, psoas major muscle, and the L4 vertebra. Using the in-plane technique, a 22G 100 mm peripheral block needle (Stimuplex® Ultra; B. Braun, Melsungen, Germany) was advanced toward the anterior aspect of the quadratus lumborum muscle, targeting the subfascial space between the quadratus lumborum and psoas major muscles. Hydrodissection was performed with 1-2 mL of 0.9% saline to confirm correct needle placement,

after which the local anesthetic was administered (Figure 1). In Group A-QLB, patients received 20 mL of a solution containing 10 mL of 0.5% bupivacaine, 9 mL of saline, and 1 mL (4 mg) of dexamethasone per side. In contrast, patients in Group QLB received 10 mL of 0.5% bupivacaine diluted with 10 mL of saline to yield a final concentration of 0.25%, and 20 mL was administered on each side.

Dermatomal Analyses

After the block procedure, a blinded anesthesiologist performed cold sensation testing at 30 minutes using an ice pack. A healthcare professional applied the ice pack to the deltoid muscle area of the shoulder to help patients recognize the sensation of cold before assessing the dermatomal regions. Each dermatome, from T4 to L2 along the midclavicular line, was assessed sequentially. The right side was tested first, then the left, to evaluate cold perception.

To prevent local warming after skin contact, the orientation of the ice pack was changed after testing each dermatome. The ice pack was applied for 2 seconds at each dermatome level. Absence of cold sensation, or a significant reduction in perception, was interpreted as sensory cutaneous blockade and was documented as dermatomal involvement. Patients whose dermatomal involvement was confirmed at 30 minutes were transferred to the operating room for surgery.

General Anesthesia Application

All patients underwent a standardized general anesthesia protocol. Induction was performed with intravenous midazolam, lidocaine, propofol, fentanyl, and rocuronium. Maintenance was performed with sevoflurane and remifentanil infusion, titrated to maintain hemodynamic stability. All LC procedures were performed by the same surgical team, using the conventional four-port method with carbon dioxide pneumoperitoneum. Intra-abdominal pressure was kept below 12 mmHg. At the end of surgery, patients received intravenous paracetamol, tramadol, and ondansetron. Neuromuscular blockade was antagonized with neostigmine and atropine. Total intraoperative remifentanil consumption was recorded. Patients were transferred to the post-anesthesia care unit for monitoring before discharge to the ward.

Postoperative Analgesia Regimen and Outcomes

All patients routinely received 1 g of paracetamol four times daily. If the resting NRS (rNRS) was ≥4, 100 mg of intravenous tramadol was given as rescue analgesia. Postoperative visits were conducted at 1, 4, 8, 12, and 24 hours by a blinded anesthesiologist, who recorded tramadol usage, time to first rescue analgesic, NRS scores at rest and during movement, dermatomal involvement, and adverse effects such as nausea, vomiting, and shoulder pain. Patients with no dermatomal involvement at 30 minutes, non-compliance with the analgesia protocol, major perioperative complications, or an operative time longer than 90 minutes were excluded. The primary outcome was total tramadol consumption within the first 24 hours, while secondary outcomes included postoperative NRS scores, time to first rescue analgesic, intraoperative remifentanil consumption, dermatomal spread, and side effects.

Sample Size and Statistical Analyses

A priori power analysis was performed using G*Power software (Version 3.1, Brunsbüttel, Germany) (11). Preliminary data indicated 24-hour tramadol consumption was 146.80±74.60 mg in the QLB group (non-adjuvant) and 113.40±65.60 mg in the A-QLB group (adjuvant). With a significance level (α) of 0.05, 80% power, and an effect size of 0.63, the study's estimated sample size was 39 per group. To account for potential conversions to open surgery and patient attrition during follow-up, 45 patients were planned for each group.

All statistical analyses were conducted using IBM SPSS Statistics 26 and IBM SPSS Amos 21. Categorical variables were summarized as counts and percentages. Continuous variables were expressed as mean ± standard deviation or median with range [median (min-max)], depending on data distribution. Normality was assessed with the Kolmogorov-Smirnov test. Parametric variables were compared using the independent samples t-test. Non-parametric data were evaluated with the Mann-Whitney U test. The chi-square or Fisher's exact test was used for categorical variables. For intragroup comparisons across repeated measures, such as postoperative pain scores, the Friedman test was used. When applicable, Bonferroni correction was applied in post-hoc analyses to determine specific time points with significant differences. Statistical significance was defined as $p<0.05$.

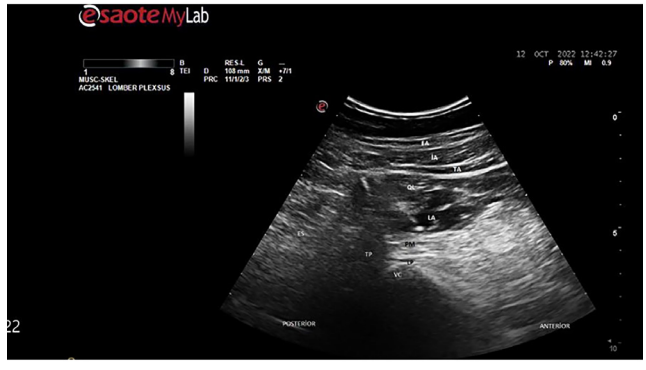

Figure 1. Ultrasound image of anterior quadratus lumborum block

Results

Patient Characteristics

In total, 83 patients were included in the final analysis (Figure 2). The groups were found to be comparable in terms of demographic variables, with no meaningful differences observed (Table 1).

Analgesic Consumption

The total tramadol consumption within the first 24 postoperative hours was similar between the adjuvant QLB group (58.97±54.86 mg, 95% CI: 41.19-76.76) and the standard QLB group (79.55±92.96 mg, 95% CI: 51.28-107.81), with no statistically significant difference (p=0.539, Cohen's d=0.122) (Table 2).

The time to first rescue analgesic was comparable between the adjuvant QLB group (4.59±3.62 h, 95% CI: 2.99-6.19) and the non-adjuvant QLB group (3.79±4.60 h, 95% CI: 1.85-5.73), with no statistically significant difference (p=0.305, Cohen's d=0.302) (Table 1).

Pain Scores

When comparing rNRS and dynamic NRS (dNRS) scores between the groups, rNRS and dNRS values at 4, 8, 12, and 24 hours were significantly lower in the A-QLB group than in the QLB group (Table 3).

Time-Dependent Tramadol Consumption

Across all recorded postoperative intervals (0-1 hours, 1-4 hours, 4-8 hours, 8-12 hours, and 12-24 hours), there were no statistically significant variations in tramadol usage between the groups (Table 4).

Dermatomal Spread

In terms of dermatomal involvement, the A-QLB group showed a significantly greater bilateral involvement in the T9, T10, and L1 dermatomes on both the right and left sides at 30 minutes compared to the QLB group (Table 5).

Postoperative Side Effects

Regarding postoperative complications, including nausea, vomiting, and shoulder pain within 24 hours, both groups demonstrated similar outcomes without any significant intergroup differences (Table 6).

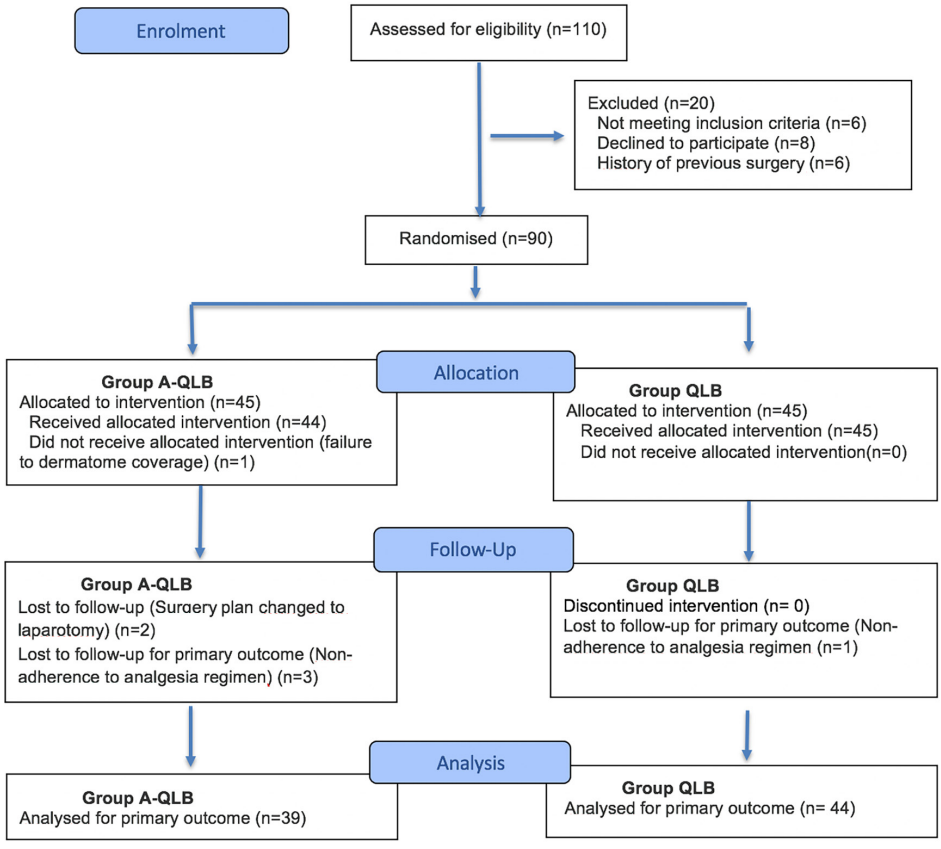

Figure 2. Consort flow diagram

OLB: Quadratus lumborum block

Table 1. Comparison of demographic data and operational durations among groups			
	Group A-QLB (n=39)	**Group QLB (n=44)**	**p**
	n (%)	**n (%)**	
Gender			
Female	31 (79.5)	33 (75)	0.6
Male	8 (20.5)	11 (25)	
	Mean ± SD	**Mean ± SD**	**p**
Age (year)	45.41±9.7	42.9±12.4	0.3
BMI (kg/m^2)	27.97±5.1	27.8±4	0.9
Operation time (minute)	55.5±18.9	57.3±15.2	0.5
Intraoperative Remifentanil Consumption (mcg/kg)	4.10±2.92	4.13±3.84	0.488
Values are presented as Mean ± SD QLB: Quadratus lumborum block, A-QLB: Anterior quadratus lumborum block, SD: Standard deviation			

Table 2. Comparison of analgesic usage between groups						
	Group A-QLB (n=39)		**Group QLB (n=44)**			
	Mean ± SD	**95% CI**	**Mean ± SD**	**95% CI**	**p**	**Effect size(d)**
Time to first rescue analgesic (hour)	4.59±3.62	2.99-6.19	3.79±4.6	1.85-5.73	0.305	0.302
Postoperative total tramadol consumption (mg/day)	58.97±54.86	41.19-76.76	79.55±92.96	51.28-107.81	0.539	0.122
Values are presented as mean ± SD and 95% QLB: Quadratus lumborum block, A-QLB: Anterior quadratus lumborum block, SD: Standard deviation, CI: Confidence interval						

Table 3. Comparison of rNRS and dNRS values between groups						
	Group A-QLB (n=39)		**Group QLB (n=44)**		**p**	**Effect size (d)**
	Mean ± SD	**95% CI**	**Mean ± SD**	**95% CI**		
rNRS 1st hour	2.59±1.52	2.10-3.08	3.59±2.35	2.88-4.30	0.060	0.412
rNRS 4th hour	1.92±1.51	1.43-2.41	2.80±1.91	2.21-3.38	**0.021***	0.508
rNRS 8th hour	1.54±0.94	1.23-1.84	2.18±1.35	1.77-2.59	**0.029***	0.470
rNRS 12th hour	1.13±1.06	0.79-1.47	1.82±1.17	1.46-2.17	**0.005***	0.616
rNRS 24th hour	0.69±0.73	0.46-0.93	1.55±1.56	1.07-2.02	**0.003***	0.637
Fr; p-value	65.345; 0.000*		65.345; 0.000*			
Difference	24<1,4,8 12<1,4 8<1		24<1,4 12<1 8<1			
dNRS 1st hour	3.69±1.73	3.13-4.25	4.61±2.46	3.87-5.36	0.096	0.365
dNRS 4th hour	3.08±1.58	2.57-3.59	4.20±2.22	3.53-4.88	**0.021***	0.515
dNRS 8th hour	2.64±1.22	2.24-3.04	3.61±1.91	3.03-4.19	**0.011***	0.566
dNRS 12th hour	2.13±1.38	1.68-2.58	3.18±1.74	2.65-3.71	**0.006***	0.616
dNRS 24th hour	1.64±1.16	1.27-2.02	2.64±2.07	2.01-3.27	**0.040***	0.450
Fr;p	57.065; 0.000*		45.634; 0.000*			
Difference	24<1,4,8 12<1,4		24<1,4 12<1			
Values are presented as mean ± SD and 95%, *=p<0.05 rNRS: Resting numeric rating scale, dNRS: Dynamic numeric rating scale, CI:Confidence interval, SD: Standard deviation						

Table 4. Comparison of tramadol usage between groups				
Tramadol usage by time interval (mg)	**Group A-QLB (n=39)**	**Group QLB (n=44)**		
	Mean ± SD 95% CI	**Mean ± SD 95% CI**	**p**	**Effect size (d)**
0-1 Hours	15.38±36.55 95% CI (3.54-27.23)	18.18±39.02 95% CI (6.32-30.04)	0.73	0.048
1-4 Hours	10.26±30.74 95% CI (0.29-20.22)	15.91±37 95% CI (4.66-27.16)	0.45	0.097
4-8 Hours	17.95±38.88 95% CI (5.35-30.55)	18.18±39.02 95% CI (6.32-30.04)	0.98	0.004
8-12 Hours	12.82±33.87 95% CI (1.84-23.80)	9.09±29.08 95% CI (0.25-17.93)	0.59	0.001
12-24 Hours	2.56±16.01 95% CI (-2.63-7.75)	13.64±34.71 95% CI (3.08-24.19)	0.07	0.064
Fr;p	4.711; 0.318	2.196; 0.700		
Values are presented as mean ± SD (95% confidence interval) QLB: Quadratus lumborum block, A-QLB: Anterior quadratus lumborum block, SD: Standard deviation, CI: Confidence interval				

Table 5. Comparison of dermatomal involvement at the 30th minutes after block application			
	Group A-QLB (n=39)	**Group QLB (n=44)**	**p**
	n (%)	**n (%)**	
Right side, 30th minute			
T7	2 (5.1)	0 (0)	-
T8	12 (30.8)	12 (27.3)	0.726
T9	27 (69.2)	21 (47.7)	**0.048***
T10	33 (84.6)	28 (63.6)	**0.031***
T11	36 (92.3)	36 (81.8)	0.16
T12	36 (92.3)	40 (90.9)	0.82
L1	33 (84.6)	28 (63.6)	**0.031***
L2	9 (23.1)	10 (22.7)	0.97
Left side, 30th minute			
T7	1 (2.6)	0 (0)	**-**
T8	12 (30.8)	12 (27.3)	0.726
T9	27 (69.2)	21 (47.7)	**0.048***
T10	34 (87.2)	25 (56.8)	**0.002***
T11	36 (92.3)	36 (81.8)	0.16
T12	36 (92.3)	42 (95.5)	0.55
L1	33 (84.6)	28 (63.6)	**0.031***
L2	9 (23.1)	9 (20.5)	0.77
Values are presented as number and percentage (n, %), *=p<0.05 QLB: Quadratus lumborum block, A-QLB: Anterior quadratus lumborum block			

Table 6. Comparison of postoperative side effects between the groups			
	Group A-QLB (n=39)	**Group QLB (n=44)**	**p**
	n (%)	**n (%)**	
Nouse	16 (41)	22 (50)	0.4
Vomiting	3 (7.7)	8 (18.2)	0.2
Shoulder pain	12 (30.8)	12 (27.3)	0.7
Values are presented as number and percentage (n, %)			

Discussion

This study found that interfascial dexamethasone combined with local anesthetics in anterior QLB blocks for LC resulted in significantly lower postoperative NRS scores. The dexamethasone group showed a broader dermatomal spread, especially at T9, T10, and L1. However, total tramadol use, intraoperative remifentanil, and time to first rescue analgesic were similar between groups.

Quadratus lumborum blocks blocks are used for postoperative pain relief in surgeries involving the lower thoracic, abdominal, retroperitoneal, and inguinal regions (12,13).

Based on the idea that the rich mechanoreceptor content in the anterior thoracolumbar fascia may offer more effective analgesia, we selected anterior QLB in this study (4,14). The anterior QLB technique was first described by Børglum (15).

Effective and long-lasting postoperative pain relief is essential for patient comfort, early discharge, and reduced hospital expenses. Adding adjuvants to local anesthetics is a promising approach to enhance the duration and effectiveness of analgesia. Many studies, including randomized trials on QLB, pectoral nerve block, and erector spinae blocks, demonstrate that adjuvants like dexamethasone or dexmedetomidine can decrease postoperative analgesic consumption, lower pain scores, and prolong the time until the first rescue

analgesia (6,16-22). However, evidence regarding the effectiveness of adjuvants in fascial plane blocks remains limited, and few studies have examined dexamethasone use with dermatomal spread. We believe our inclusion of dermatomal analysis provides a new contribution and an innovative perspective in evaluating analgesic effectiveness.

In our study, the total tramadol consumption within 24 hours was 58.97±54.86 mg in the adjuvant group and 79.55±92.96 mg in the non-adjuvant group, with no statistically significant difference between the groups. However, the consumption values showed a trend favoring the adjuvant group. Similarly, the time to first rescue analgesia was 3.79±4.6 hours in the non-adjuvant group and 4.59±3.62 hours in the adjuvant group. Although the difference was not statistically significant, it was longer in the adjuvant group. We believe that the differences between our findings and those reported in the literature may be partly related to sample size. Furthermore, while most previous studies primarily focused on analgesic consumption as the main indicator of efficacy, our study differed by including NRS scores and dermatomal analysis in the evaluation. This methodological difference offers additional insight into the analgesic effects of adjuvant dexamethasone and could explain the variability seen across studies.

Although dexamethasone is widely used, its perineural application is considered off-label by both the US. Food and Drug Administration and the European Medicines Agency, which raises concerns among some practitioners. As a result, intravenous administration has become more common in recent years. When reviewing the literature on whether adjuvants should be given intravenously or added directly to local anesthetics, we noted concerns about precipitation and crystallization that may occur due to the alkalinization of local anesthetic solutions (23). However, relevant publications show that precipitation is more likely with ropivacaine (more acidic than bupivacaine), especially when combined with more alkaline steroids like betamethasone (23,24). In our study, we used bupivacaine and dexamethasone. Previous research indicates that precipitation is more often seen in alkaline environments and is rare with bupivacaine. We did not observe any turbidity or signs of precipitation in our local anesthetic mixture.

In recent years, the intravenous administration of dexamethasone as an adjuvant has been widely discussed. However, studies by Abdellatif et al. (25) and Arafa et al. (26) showed that interfascial administration of dexamethasone is more effective than intravenous use. Two meta-analyses further confirmed that perineural dexamethasone extends analgesia more effectively than intravenous administration, without evidence of neurological complications, infection risk, or significant hyperglycemia (27,28). Dexamethasone is thought to improve the quality and duration of peripheral nerve blocks by reducing the release of inflammatory mediators, suppressing ectopic neuronal discharge, and inhibiting potassium channel-mediated depolarization in nociceptive C-fibers (29-31). In our study, we specifically chose the interfascial route because of the relatively poor vascularity of this anatomical plane, which we expected would lead to a longer duration of action. If systemic absorption had been predominant in this setting, a lower incidence of postoperative nausea and vomiting (PONV) would have been expected in patients receiving dexamethasone; however, the similar rates of PONV between groups suggest otherwise. This interpretation is further supported by previous reports consistently showing the strong antiemetic effect of intravenous dexamethasone (32).

In this study, patients who received dexamethasone showed significantly lower rNRS and dNRS scores at the 4^{th}, 8^{th}, 12^{th}, and 24^{th} postoperative hours, indicating that dexamethasone improved the analgesic effectiveness of the local anesthetic. These results align with previous studies on adjuvant use and match the observation that dermatomal involvement was more common in the adjuvant group.

Furthermore, analgesic consumption during the 12-24 hours period was lower in the A-QLB group than in the QLB group (2.56±16.01 vs. 13.64±34.71, respectively). Although this difference did not achieve statistical significance, the lower tramadol requirement in the adjuvant group during this period was viewed as an indication of dexamethasone's effectiveness. This result, along with decreased NRS scores and more widespread dermatomal spread, suggests that dexamethasone may extend the duration of local anesthetic effects in interfascial plane blocks and thus enhance effective and longer-lasting postoperative pain relief.

There have been no documented cases of dexamethasone-related neuronal damage so far. Conversely, cell-level studies in mice indicate that dexamethasone might reduce the neurotoxic effects of bupivacaine (33-35). Additionally, concerns about the potential for dexamethasone to increase surgical site infection risk have led some clinicians to restrict its use. However, Jones et al. (36) reported in their meta-analysis that perioperative dexamethasone use in diabetic patients does not raise the risk of infection. While the current data support its early safety, long-term prospective studies are limited. Therefore, more research is needed to understand long-term outcomes.

Dermatomal involvement at 30 minutes was broader in the adjuvant group compared to the non-adjuvant group. In QLB blocks, dermatomal involvement typically occurs

within the T7-L1 range, although the literature has reported extensions into both higher and lower dermatomal levels. In this study, cutaneous sensory blockade was primarily observed in the T9-L1 dermatomes.

At the 30th minute, involvement of the T9, T10, and L1 dermatomes on both the right and left sides was significantly greater in the adjuvant group. The involvement of the T11-T12 dermatomes was similar between the two groups. In both groups, bilateral sensory cutaneous blockade in the T11-T12 dermatomes was observed in 80-95% of patients. Sensory cutaneous blockade was most frequently noted in the T10-L1 dermatomes in both groups. These findings are consistent with the literature (37).

The difference in dermatomal involvement between the groups was linked to the lower NRS scores seen in the adjuvant group. Since previous studies have not examined dermatomal involvement, we could not compare our findings on the relationship between dermatomal spread and pain relief with those studies. The greater dermatomal spread in the adjuvant group, especially in the T9, T10, and L2 dermatomes, may be related to how dexamethasone works and how anterior QLB blocks might extend into the paravertebral space. A key strength of our study is the inclusion of dermatomal analysis, which allowed us to show the connection between dermatomal spread and pain relief-a new contribution that sets our work apart from previous research and could guide clinical practice.

Although QLB primarily targets the lower thoracic and upper lumbar dermatomes (T9-L1), our study involving patients undergoing LC showed cutaneous sensory involvement in the T8-L2 range. Since LC procedures involve both somatic pain from trocar incisions and visceral pain related to CO_2 insufflation and gallbladder manipulation, we believe that QLB can significantly contribute to multimodal analgesia protocols. While transversus abdominis plane blocks generally provide only somatic analgesia and may be inadequate for complete sensory blockade of the abdominal wall, erector spinae plane blocks—although effective against visceral pain—are more technically difficult to perform. Visualizing the spread of local anesthetic using an in-plane approach in ESP blocks is not always possible. In contrast, anterior QLB is easier to perform under USG guidance. The lower NRS scores observed in our study further support the potential usefulness of QLB, especially when combined with dexamethasone as an adjuvant, for postoperative pain management in LC.

In this study, dexamethasone was administered via the interfascial route rather than intravenously. Beyond the reduced vascularization in the interfascial area, which limits systemic absorption and prolongs local action, this route also provides additional advantages. The anterior QLB has the potential to spread to the paravertebral and epidural spaces, enabling dexamethasone to exert analgesic effects through the inhibition of NF-κB, a transcription factor involved in central sensitization and pathological pain (9,10). In addition, the vasoconstrictive properties of steroids may further decrease systemic uptake and contribute to extending the duration of analgesia. Collectively, these anatomical and pharmacological mechanisms support the use of dexamethasone as an effective adjuvant to enhance and prolong postoperative analgesia, particularly in inflammatory and incisional pain.

Study Limitations

A major limitation of our study was the inability to analyze postoperative dermatomal areas. Patients were sedated and under the influence of analgesic medications following general anesthesia, which could compromise data reliability. In addition, dermatomal testing at thoracic entry sites carries a potential risk of cutaneous nerve injury, further limiting its feasibility. Another limitation was the relatively short follow-up period (24 hours), since patients were routinely discharged within this timeframe. This prevented the evaluation of prolonged analgesic effects, even though the duration of action of interfascial dexamethasone may be longer due to reduced vascularization and delayed absorption. In addition, the lack of long-term follow-up restricted the ability to definitively evaluate the clinical outcomes of dexamethasone administration. Furthermore, the single-center design and relatively young ASA I–II population may restrict the generalizability of the findings and the study might also be underpowered for some secondary outcomes.

Despite these limitations, this study has several strengths. Its prospective, randomized, and double-blinded design enhances methodological rigor, and the use of standardized anesthesia and surgical protocols ensures homogeneity across groups. Moreover, the analysis of dermatomal spread in the adjuvant anterior QLB group represents a unique and original contribution to the literature, offering clearer insights into the role of dexamethasone in enhancing analgesic efficacy.

Conclusion

These findings demonstrate that the addition of dexamethasone to QLB may provide clinical advantages in terms of both more effective pain control and broader dermatomal spread. Moreover, the administration of dexamethasone into the interfascial plane, unlike dexamethasone's use in extremity blocks, may offer additional benefits due to reduced vascularization. Taken together, these results highlight the need for further studies to evaluate the efficacy of adjuvants in fascial plane blocks.

Ethics

Ethics Committee Approval: Ethical approval was obtained from the University of Health Sciences Türkiye Gaziosmanpasa Training and Research Hospital Clinical Research Ethics Committee under the registration number (approval no.: 40, date: 10.05.2023).

Informed Consent: Only patients who gave signed informed consent prior to participation were included.

Footnotes

Authorship Contributions

Surgical and Medical Practices: S.S., D.G.M., B.B., Concept: S.S., D.G.M., V.D., Design: S.S., D.G.M., V.D., Data Collection or Processing: S.S., O.O., B.B., V.D., Analysis or Interpretation: S.S., O.O., B.B., Literature Search: S.S., O.O., D.G.M., Writing: S.S.

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