E-ISSN 2250-0944
ISSN 2250-1150
doi: 10.31838/ijprt/16.02.611

Research Article

Effect of Ultrasound-Guided Quadratus Lumborum Block on Diaphragmatic Excursion in Patients Undergoing Abdominal Surgery

Dr. Sumangala[1], Dr. Kavita M[2], Dr. Tooba Firdous[3*]
[1*]Assistant Professor, Department of Anaesthesiology, Raichur Institute of Medical Sciences (RIMS), Raichur, Karnataka, India.
[2]Registrar, Department of Anaesthesiology, Apollo Hospital, Bannerghatta, Bengaluru, Karnataka, India.
[3*]Senior Resident, Department of Anaesthesiology, Raichur Institute of Medical Sciences (RIMS), Raichur, Karnataka, India.
Corresponding Author: Dr. Tooba Firdous
Senior Resident, Department of Anaesthesiology, Raichur Institute of Medical Sciences (RIMS), Raichur, Karnataka, India.
Received: 09.05.2026, Revised: 04.06.2026, Accepted: 28.06.2026

ABSTRACT
Background: Quadratus lumborum block (QLB) provides effective analgesia after abdominal surgery, but its effect on diaphragmatic function remains unclear. This study evaluated changes in diaphragmatic excursion following ultrasound-guided QLB.
Methods: This prospective observational study included 100 adults undergoing elective abdominal surgery under general anaesthesia with QLB. Diaphragmatic excursion was assessed using M-mode ultrasonography at baseline and predefined postoperative intervals. Pain scores, rescue analgesia, oxygen saturation, and respiratory complications were recorded.
Results: Mean diaphragmatic excursion decreased from 1.82 ± 0.35 cm at baseline to 1.68 ± 0.33 cm at 30 minutes ($p<0.001$), improving to 1.75 ± 0.34 cm at 2 hours and 1.80 ± 0.35 cm at 6 hours. Reduction was >20% in only 7% of patients. Rescue analgesia was required in 23%. Patients with >20% reduction had lower SpO_2 (95.9 ± 1.5% vs 97.6 ± 1.2%; $p=0.001$) and greater supplemental oxygen requirement (42.9% vs 7.5%; $p=0.019$). Pulmonary complications occurred in 2%.
Conclusion: QLB provided satisfactory postoperative analgesia with a mild, transient reduction in diaphragmatic excursion. Diaphragmatic movement approached baseline by 6 hours, with clinically significant respiratory complications being uncommon.

Keywords: Quadratus Lumborum Block, Diaphragmatic Excursion, Ultrasonography, Abdominal Surgery, Postoperative Analgesia.

INTRODUCTION

Abdominal surgery is commonly associated with significant postoperative pain and impairment of respiratory mechanics. Pain from abdominal incisions may restrict deep inspiration and effective coughing, resulting in shallow breathing, reduced lung volumes, secretion retention, atelectasis, and postoperative pulmonary complications[1]. General anaesthesia, residual neuromuscular blockade, pneumoperitoneum, and surgical manipulation may further compromise respiratory function. Postoperative diaphragmatic dysfunction is particularly relevant because the diaphragm is the principal muscle of inspiration, and reduced diaphragmatic mobility following major abdominal surgery has been associated with an increased risk of postoperative pulmonary complications.[2,3]Effective postoperative analgesia is therefore important not only for patient comfort but also for preservation of respiratory function and early recovery. Increasing emphasis on opioid-sparing multimodal analgesia has encouraged the use of ultrasound-guided fascial plane blocks in abdominal surgery. Among these, the quadratus lumborum block (QLB) has emerged as an effective regional analgesic technique for abdominal and pelvic procedures.[4,5] QLB involves deposition of local anaesthetic within fascial planes surrounding the quadratus lumborum muscle, with the analgesic effect attributed to spread along the thoracolumbar and transversalis fascia and possible cranial extension toward the thoracic paravertebral space.[6,7]Several approaches to QLB have been described according to the site of local anaesthetic deposition. These include the lateral (QLB-1), posterior (QLB-2), and anterior or transmuscular (QLB-3) approaches.[6,8] Differences in the site of injection influence the pattern and extent of local anaesthetic spread

and may consequently affect the clinical characteristics of the block. The potential cranial spread of local anaesthetic is particularly relevant to respiratory function. Anatomical and imaging studies suggest that injectate around the quadratus lumborum may extend cranially through fascial pathways related to the arcuate ligaments and diaphragmatic zone of apposition toward the lower thoracic paravertebral region.[6,9]This anatomical relationship raises the possibility that QLB may influence diaphragmatic mechanics. Conversely, effective analgesia following QLB may improve respiratory function by reducing pain-related splinting and facilitating deeper inspiration and effective coughing. Thus, its overall effect on diaphragmatic movement may reflect an interaction between analgesic benefit and the anatomical distribution of local anaesthetic. Although the analgesic and opioid-sparing effects of QLB in abdominal surgery have been extensively investigated,[4,5,10] its influence on diaphragmatic function remains comparatively less explored.Ultrasonography provides a simple, non-invasive, radiation-free, and repeatable bedside method for evaluating diaphragmatic function. Diaphragmatic excursion, representing displacement of the diaphragm during respiration, can be objectively measured using ultrasonography and permits serial assessment during the perioperative period. Previous studies have demonstrated significant postoperative alterations in diaphragmatic movement following major abdominal and laparoscopic surgery, supporting its usefulness as an objective indicator of diaphragmatic function.[1,2,11]However, direct evidence regarding the effect of QLB on diaphragmatic excursion remains limited. Therefore, the present study was designed to evaluate the effect of ultrasound-guided quadratus lumborum block on diaphragmatic excursion in patients undergoing abdominal surgery.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Anaesthesiology at a tertiary care teaching hospital. A total of 100 adult patients undergoing elective abdominal surgery under general anaesthesia and receiving ultrasound-guided quadratus lumborum block (QLB)

Eligibility Criteria

Patients aged 18–65 years, of either sex, with ASA physical status I–III, scheduled for elective abdominal surgery were included. Patients with refusal to participate, allergy to local anaesthetics, coagulopathy, infection at the block site, significant respiratory or neuromuscular disease, pre-existing diaphragmatic dysfunction, or contraindication to QLB were excluded.

Diaphragmatic Excursion

Baseline diaphragmatic excursion was assessed preoperatively in the supine position using a low-frequency curvilinear ultrasound probe. After identifying the diaphragm in B-mode, M-mode ultrasonography was used to measure excursion as the distance between the end-expiratory position and maximum inspiratory displacement. Three consecutive measurements were obtained, and the mean value was recorded.

Anaesthesia and QLB Technique

Standard monitoring was instituted, and general anaesthesia was administered according to institutional protocol. Ultrasound-guided QLB was performed under aseptic precautions using an in-plane needle technique. After identification of the quadratus lumborum and surrounding structures, a predetermined volume and concentration of local anaesthetic was administered following confirmation of appropriate needle-tip position. The same QLB approach, local anaesthetic concentration, and volume were used in all patients.

Outcome Assessment

Diaphragmatic excursion was measured at baseline and predefined intervals following QLB and postoperatively using the same ultrasound technique. The primary outcome was the change in diaphragmatic excursion from baseline following QLB. Secondary outcomes included postoperative pain scores, rescue analgesic requirement, oxygen saturation, respiratory complications, and block-related adverse events.

Statistical Analysis

Data were analysed using SPSS.21statistical software. Continuous variables were expressed as mean ± SD or median (IQR), and categorical variables as frequency and percentage. Normality was assessed using the Shapiro–Wilk test. Pre- and post-block diaphragmatic excursion was compared using the paired t-test or Wilcoxon signed-rank test, as appropriate. For multiple time-point comparisons, repeated-measures ANOVA or the Friedman test was used. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 100 patients undergoing quadratus lumborum block (QLB) were included in the

study. The mean age was 44.6 ± 12.3 years, with 56% males and 44% females. The mean BMI was 24.9 ± 3.6 kg/m². Most patients belonged to ASA physical status II (59%), followed by ASA I (34%) and ASA III (7%). The mean duration of surgery was 112.5 ± 31.8 minutes. Baseline mean SpO_2 was 98.1 ± 1.2%, while the mean baseline diaphragmatic excursion was 1.82 ± 0.35 cm (Table 1).

Following QLB, a significant transient reduction in diaphragmatic excursion was observed. The mean diaphragmatic excursion decreased from 1.82 ± 0.35 cm at baseline to 1.68 ± 0.33 cm at 30 minutes, corresponding to a mean reduction of 0.14 cm (7.7%; $p<0.001$). At 2 hours, the mean excursion was 1.75 ± 0.34 cm, representing a 3.8% reduction from baseline ($p=0.004$). By 6 hours, diaphragmatic excursion had increased to 1.80 ± 0.35 cm, with only a 1.1% reduction from baseline, which was not statistically significant ($p=0.318$) (Table 2).

According to the maximum reduction in diaphragmatic excursion, 72% of patients experienced a reduction of <10%, 21% had a reduction of 10–20%, and only 7% demonstrated a reduction >20%. Thus, 93% of patients had ≤20% reduction in diaphragmatic excursion following QLB (Table 3, Figure 1).

Postoperative pain scores remained relatively low following QLB. The mean VAS scores at 2, 6, 12, and 24 hours were 2.1 ± 1.0, 2.5 ± 1.1, 3.2 ± 1.2, and 2.8 ± 1.1, respectively. Rescue analgesia was required in 23% of patients, whereas 77% did not require rescue analgesia. Among patients requiring rescue analgesia, the mean time to first rescue analgesic was 9.6 ± 3.4 hours (Table 4, Figure 2).

Respiratory outcomes differed according to the magnitude of reduction in diaphragmatic excursion. Patients with >20% reduction had a significantly lower mean SpO_2 at 30 minutes compared with those with ≤20% reduction (95.9 ± 1.5% vs. 97.6 ± 1.2%; $p=0.001$). Supplemental oxygen was also required more frequently among patients with >20% reduction (42.9% vs. 7.5%; $p=0.019$). Respiratory symptoms occurred in 14.3% versus 2.2% ($p=0.197$), while pulmonary complications occurred in 14.3% versus 1.1% ($p=0.135$), respectively; these differences were not statistically significant (Table 5).

Correlation analysis demonstrated that greater percentage reduction in diaphragmatic excursion was significantly associated with increasing age ($r=0.22$, $p=0.028$) and BMI ($r=0.20$, $p=0.046$). Baseline diaphragmatic excursion showed a significant negative correlation with percentage reduction ($r=-0.26$, $p=0.009$). Greater reduction was also positively correlated with VAS score at 2 hours ($\rho=0.31$, $p=0.002$) and negatively correlated with SpO_2 at 30 minutes ($r=-0.35$, $p<0.001$). Duration of surgery showed no significant correlation ($r=0.16$, $p=0.112$) (Table 6, Figure 3).

Overall, the findings demonstrate that QLB was associated with a small, predominantly transient reduction in diaphragmatic excursion, maximal at 30 minutes and approaching baseline by 6 hours. A reduction exceeding 20% occurred in only 7% of patients but was associated with lower early postoperative oxygen saturation and a greater requirement for supplemental oxygen.

Table 1. Baseline Demographic and Perioperative Characteristics (N=100)

Parameter	Value
Age (years), mean ± SD	44.6 ± 12.3
Male, n (%)	56 (56.0)
Female, n (%)	44 (44.0)
BMI (kg/m²), mean ± SD	24.9 ± 3.6
ASA I, n (%)	34 (34.0)
ASA II, n (%)	59 (59.0)
ASA III, n (%)	7 (7.0)
Duration of surgery (min), mean ± SD	112.5 ± 31.8
Baseline SpO_2 (%), mean ± SD	98.1 ± 1.2
Baseline diaphragmatic excursion (cm), mean ± SD	1.82 ± 0.35

Table 2. Changes in Diaphragmatic Excursion at Different Time Points

Time point	Diaphragmatic excursion (cm), mean ± SD	Change from baseline (cm)	Percentage change	p-value
Baseline	1.82 ± 0.35	—	—	—

30 min after QLB	1.68 ± 0.33	−0.14	−7.7%	<0.001
2 hours	1.75 ± 0.34	−0.07	−3.8%	0.004
6 hours	1.80 ± 0.35	−0.02	−1.1%	0.318

Table 3. Distribution According To Maximum Reduction in Diaphragmatic Excursion

Reduction in diaphragmatic excursion	n (%)
<10%	72 (72.0)
10–20%	21 (21.0)
>20%	7 (7.0)
Total	100 (100.0)

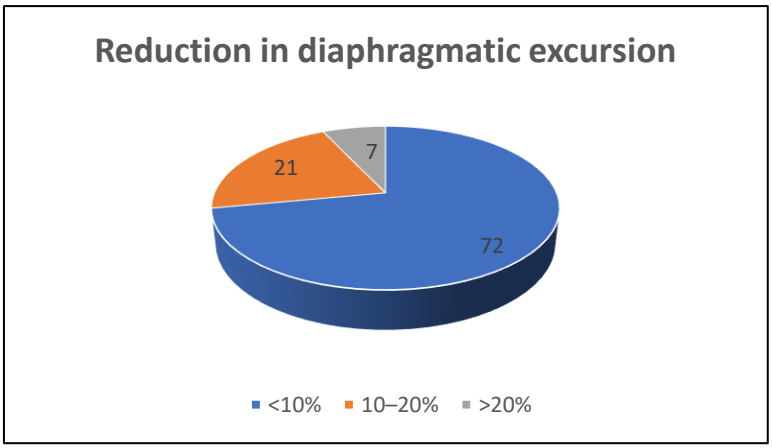


Figure 1. Distribution According To Maximum Reduction in Diaphragmatic Excursion

Table 4. Postoperative Analgesic Outcomes Following QLB

Parameter	Value
VAS at 2 hours, mean ± SD	2.1 ± 1.0
VAS at 6 hours, mean ± SD	2.5 ± 1.1
VAS at 12 hours, mean ± SD	3.2 ± 1.2
VAS at 24 hours, mean ± SD	2.8 ± 1.1
Rescue analgesia required, n (%)	23 (23.0)
No rescue analgesia required, n (%)	77 (77.0)
Time to first rescue analgesia (hours)*	9.6 ± 3.4

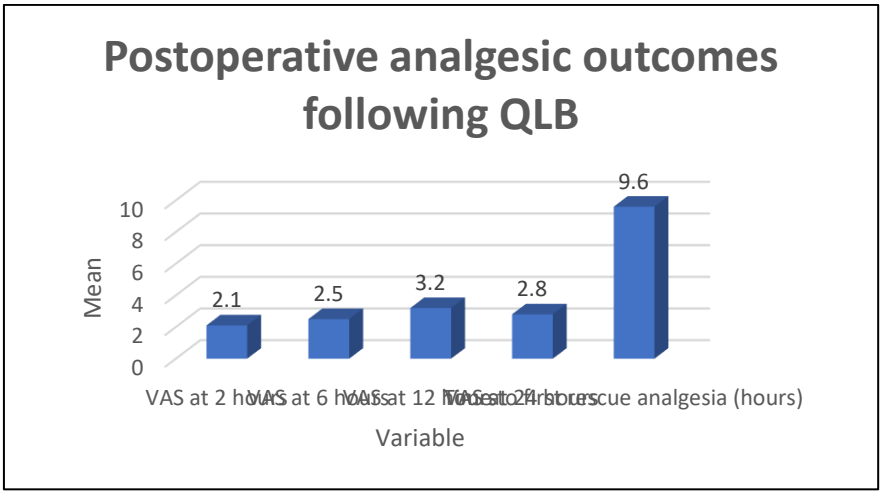


Figure 2. Postoperative Analgesic Outcomes Following QLB

Table 5. Respiratory Outcomes According To Reduction in Diaphragmatic Excursion

Parameter	≤20% reduction (n=93)	>20% reduction (n=7)	p-value	Statistical test
SpO_2 at 30 min (%), mean ± SD	97.6 ± 1.2	95.9 ± 1.5	0.001	Independent t-test
Supplemental oxygen required, n (%)	7 (7.5)	3 (42.9)	0.019	Fisher's exact test
Respiratory symptoms, n (%)	2 (2.2)	1 (14.3)	0.197	
Pulmonary complication, n (%)	1 (1.1)	1 (14.3)	0.135	

Table 6. Correlation of Clinical Variables with Percentage Reduction in Diaphragmatic Excursion

Variable	Correlation coefficient (r/ρ)	p-value	Statistical test
Age	0.22	0.028	Pearson correlation
BMI	0.20	0.046	Pearson correlation
Duration of surgery	0.16	0.112	Pearson correlation
Baseline diaphragmatic excursion	−0.26	0.009	Pearson correlation
VAS at 2 hours	0.31	0.002	Spearman correlation
SpO_2 at 30 min	−0.35	<0.001	Pearson correlation

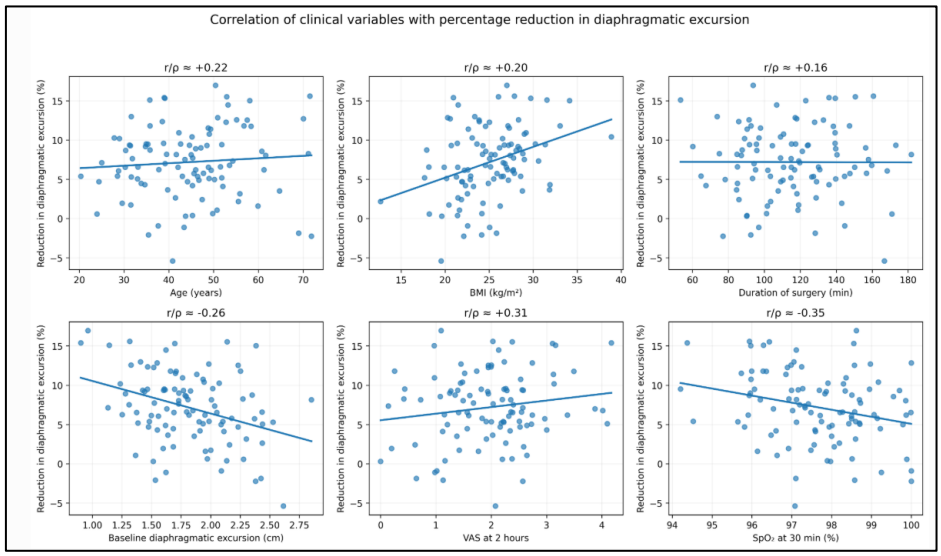


Figure 3. Correlation of Clinical Variables with Percentage Reduction in Diaphragmatic Excursion

DISCUSSION

The present study evaluated diaphragmatic excursion following ultrasound-guided quadratus lumborum block (QLB) in 100 patients undergoing abdominal surgery. Mean diaphragmatic excursion decreased from 1.82 ± 0.35 cm at baseline to 1.68 ± 0.33 cm at 30 minutes (7.7% reduction; p<0.001), improved to 1.75 ± 0.34 cm at 2 hours, and returned close to baseline at 6 hours (1.80 ± 0.35 cm; p=0.318). Most patients (72%) had <10% reduction, while only 7% demonstrated >20% reduction, suggesting that the effect on diaphragmatic movement was predominantly mild and transient.

Postoperative analgesia was satisfactory, with mean VAS scores of 2.1 ± 1.0, 2.5 ± 1.1, 3.2 ± 1.2, and 2.8 ± 1.1 at 2, 6, 12, and 24 hours, respectively. Only 23% required rescue analgesia, with a mean time to first rescue analgesia of 9.6 ± 3.4 hours.

These findings are consistent with Kadam,[12] who reported effective postoperative analgesia following QLB after laparotomy, with low pain scores and limited opioid requirement. Visoiu and Yakovleva[11] similarly demonstrated successful continuous postoperative analgesia using QLB as an alternative to transversus abdominis plane block. Chakraborty et al.[14] also reported effective continuous QLB

analgesia in a paediatric patient, supporting the prolonged analgesic potential of this technique. Murouchi et al.[12] studied 11 patients receiving bilateral QLB with 20 mL of 0.375% ropivacaine on each side during laparoscopic ovarian surgery. They reported sensory blockade extending approximately from T7 to T12 and an analgesic duration exceeding 24 hours, significantly longer than lateral TAP block (p=0.003). These observations support the effective and relatively extensive analgesia observed in our patients.

The transient 7.7% reduction in diaphragmatic excursion observed at 30 minutes may be related to the anatomical spread of local anaesthetic. Karmakar et al.[13] demonstrated thoracolumbar anaesthesia and paravertebral spread following low thoracic paravertebral injection

Carline et al.[14], in a cadaveric comparison of three QLB approaches, demonstrated that the extent of dye spread and nerve involvement differed according to the site of injection, indicating considerable variation in the anatomical distribution of QLB. Dam et al.[15] studied 16 injections in eight cadavers and demonstrated extension of injectate into the thoracic paravertebral and intercostal spaces, with cephalad spread occurring posterior to the medial and lateral arcuate ligaments of the diaphragm. These anatomical findings provide a plausible explanation for the early, transient alteration in diaphragmatic excursion observed in our study, although the cited cadaveric studies did not directly assess diaphragmatic function.

Patients with >20% reduction in diaphragmatic excursion had lower SpO_2 than those with ≤20% reduction (95.9 ± 1.5% vs 97.6 ± 1.2%; p=0.001) and more frequently required supplemental oxygen (42.9% vs 7.5%; p=0.019). Nevertheless, respiratory symptoms occurred in only 3% and postoperative pulmonary complications in 2% of the overall cohort. Thus, the reduction in diaphragmatic excursion was generally transient and was infrequently accompanied by clinically important respiratory consequences.

Percentage reduction in diaphragmatic excursion showed weak positive correlations with age (r=0.22, p=0.028) and BMI (r=0.20, p=0.046), and a stronger correlation with postoperative VAS score (ρ=0.31, p=0.002). It was negatively correlated with baseline diaphragmatic excursion (r=−0.26, p=0.009) and SpO_2 at 30 minutes (r=−0.35, p<0.001). Duration of surgery was not significantly associated with diaphragmatic reduction (r=0.16, p=0.112). These findings suggest that postoperative diaphragmatic movement may be influenced by both patient-related factors and pain, in addition to the anatomical effects of QLB.

No local anaesthetic systemic toxicity, block-site haematoma, or pneumothorax occurred. Murouchi et al.[12] similarly reported lower peak arterial ropivacaine concentrations following QLB than lateral TAP block (1.0 ± 0.5 vs 1.8 ± 0.4 μg/mL; p=0.0003), supporting a favourable systemic safety profile.

CONCLUSION

Ultrasound-guided quadratus lumborum block provided effective postoperative analgesia with only a mild and transient reduction in diaphragmatic excursion following abdominal surgery. Diaphragmatic excursion approached baseline by 6 hours, and clinically significant respiratory complications were uncommon. QLB therefore appears to provide satisfactory analgesia with limited short-term effects on diaphragmatic function.

Limitations

The study was single-centre with a relatively small sample size and lacked a control group for comparison. Additionally, longer-term diaphragmatic function and differences between various QLB approaches were not evaluated.

REFERENCES

1. Vanamail PV, Balakrishnan K, Prahlad S, Chockalingam P, Dash R, Soundararajan DK. Ultrasonographic assessment of diaphragmatic inspiratory amplitude and its association with postoperative pulmonary complications in upper abdominal surgery: a prospective, longitudinal, observational study. Indian J Crit Care Med. 2021;25(9):1031-9.
2. Zhang Y, et al. Maximal inspiratory diaphragmatic ultrasound predicts postoperative pulmonary complications after upper abdominal surgery. Ann Intensive Care. 2025;15:121.
3. Jimenez-Santana JD, Azzolina D, Scaramuzzo G, Mazzinari G, Dres M, Fogagnolo A, et al. Ultrasound-detected postoperative diaphragmatic dysfunction and its association with pulmonary complications: a systematic review and meta-analysis. J Clin Anesth. 2025;107:112027.

4. Kadam VR, Ludbrook G, van Wijk RM, Hewett PJ, Moran JL, Thiruvenkatarajan V, et al. Comparison of ultrasound-guided transmuscular quadratus lumborum block catheter technique with surgical pre-peritoneal catheter for postoperative analgesia in abdominal surgery: a randomised controlled trial. Anaesthesia. 2019;74(11):1381-8.
5. Zhu Q, Li L, Yang Z, Shen J, Zhu R, Wen Y, et al. Ultrasound guided continuous quadratus lumborum block hastened recovery in patients undergoing open liver resection: a randomized controlled, open-label trial. BMC Anesthesiol. 2019;19:23.
6. Ueshima H, Otake H, Lin JA. Ultrasound guided quadratus lumborum block: an updated review of anatomy and techniques. Biomed Res Int. 2017;2017:2752876.
7. Carney J, Finnerty O, Rauf J, Bergin D, Laffey JG, McDonnell JG. Studies on the spread of local anaesthetic solution in transversus abdominis plane blocks. Anaesthesia. 2011;66:1023-30.
8. Börglum J, Moriggl B, Lonnqvist PA, et al. Ultrasound-guided transmuscular quadratus lumborum blockade. Br J Anaesth. 2013;111:eLetters Supplement.
9. Elsharkawy H, et al. Quadratus lumborum block with paramedian sagittal oblique (subcostal) approach. Anaesthesia. 2016;71.
10. Huang D, Song L, Li Y, Xu Z, Li X, Li C. Posteromedial quadratus lumborum block versus transversus abdominal plane block for postoperative analgesia following laparoscopic colorectal surgery: a randomized controlled trial. J Clin Anesth. 2020;62:109716.
11. Visoiu M, Yakovleva N. Continuous postoperative analgesia via quadratus lumborum block: an alternative to transversus abdominis plane block. Paediatr Anaesth. 2013;23:959–61.
12. 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.
13. Karmakar MK, Gin T, Ho AMH. Ipsilateral thoraco-lumbar anaesthesia and paravertebral spread after low thoracic paravertebral injection. Br J Anaesth. 2001;87:312–6.
14. Carline L, McLeod GA, Lamb C. A cadaver study comparing spread of dye and nerve involvement after three different quadratus lumborum blocks. Br J Anaesth. 2016;117(3):387–94.
15. Dam M, Moriggl B, Hansen CK, Hoermann R, Bendtsen TF, Børglum J. The pathway of injectate spread with the transmuscular quadratus lumborum block: a cadaver study. Anesth Analg. 2017;125(1):303–12.