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REVIEW

# Postoperative Analgesic Effects of Quadratus Lumborum Block Versus Transversus Abdominis Plane Block in Pediatric Lower Abdominal Surgeries: A Systematic Review and Meta-Analysis

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**Objective:** Management of postoperative pain in pediatric patients is challenging. Traditional methods of postoperative pain management may not always provide adequate relief. We aim to compare the effect of Quadratus Lumborum Block (QLB) and Transversus Abdominis Plane Block (TAPB) on the quality of postoperative analgesia in pediatrics undergoing lower abdominal surgeries.

**Methods:** We systematically searched PubMed, Scopus, Web of Science, and Cochrane Library up to August 2024 for studies that compared QLB and TAPB in the context of pediatric lower abdominal surgery. Pooled mean difference (MD), standardized mean difference (SMD), and odds ratio (OR) were calculated by a random effect model using RevMan 5.4.

**Results:** Nine studies met the pre-defined inclusion criteria. Pooled analysis indicated that postoperative pain measured by the FLACC score was lower in the QLB group compared to the TAPB group (MD: −0.37; 95% CI: −0.51, −0.23; P < 0.00001). QLB was also associated with lower rescue analgesic demand (OR: 0.25; 95% CI, 0.13, 0.49; P < 0.0001), higher parent satisfaction (SMD: 0.78; 95% CI: 0.53, 1.02; P < 0.00001), longer time without the need for analgesic administration (MD: 1.04; 95% CI: 0.38, 1.71; P = 0.002), and lower paracetamol consumption (SMD: −1.40; 95% CI: −2.43, −0.36; P = 0.008). However, no significant difference was found in terms of postoperative nausea, vomiting, and heart rate.

**Conclusion:** QLB provides superior analgesia compared to TAPB in pediatrics undergoing lower abdominal surgeries.

**Keywords:** QL block, TAP block, pediatric, abdominal surgeries, meta-analysis

## Introduction

The management of postoperative pain in pediatric patients undergoing lower abdominal surgeries presents a significant clinical challenge.[1] This population faces unique considerations due to their developmental stage, physiological differences from adults, and the potential long-term impact of inadequate pain control on both physical and psychological well-being.[2] Lower abdominal surgeries, including procedures such as hernia repair, appendectomy, and certain types of urological interventions, are common in pediatric practice.[3] These operations often involve tissue trauma and inflammation in areas richly innervated, potentially leading to substantial postoperative discomfort and distress.[4]

Traditional methods of postoperative pain management in children, such as systemic opioids and nonsteroidal anti-inflammatory drugs (NSAIDs), may not always provide adequate relief, especially for more invasive procedures.[5] These approaches can also be associated with side effects like sedation, nausea, and respiratory depression, which may complicate



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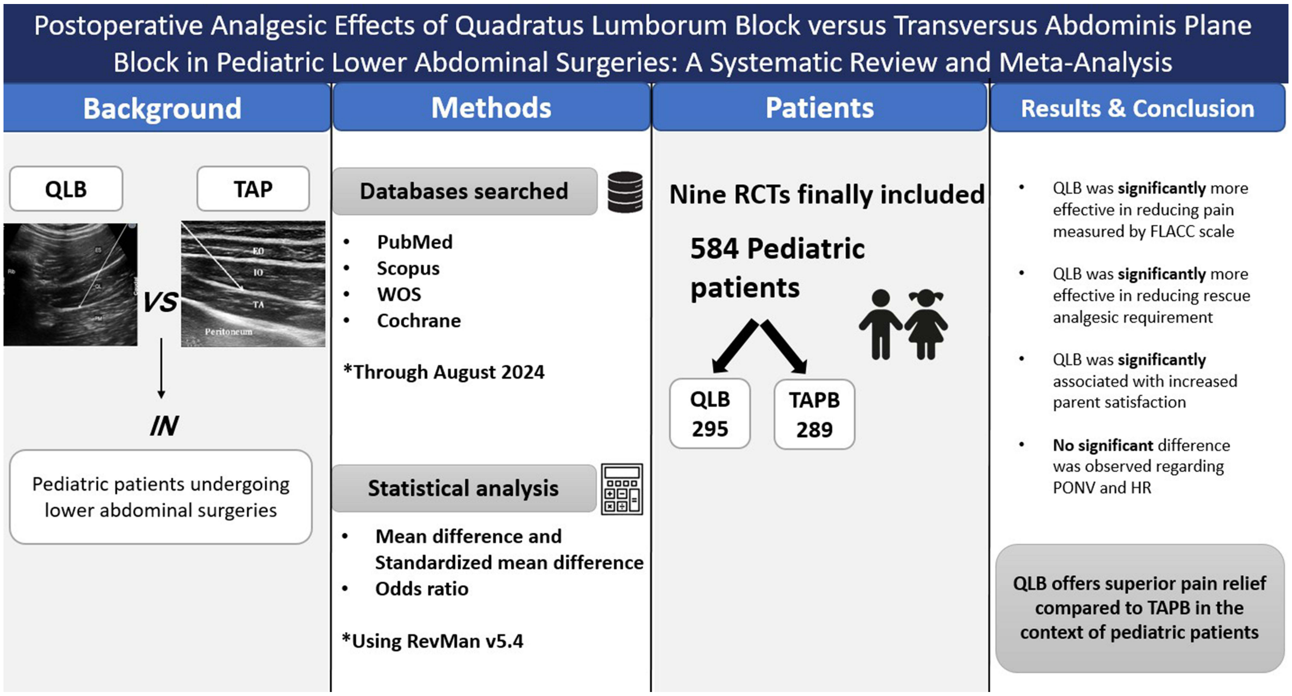
**Graphical Abstract**




postoperative care and recovery.[6] In recent years, regional anesthesia techniques have emerged as promising alternatives for postoperative pain management in various surgical populations.[7] Two specific regional blocks that have gained attention for their potential benefits in reducing postoperative pain after abdominal surgeries is the Quadratus Lumborum Block (QLB) and the Transversus Abdominis Plane block (TAPB).[8]

The QLB targets the nerves supplying the lumbar plexus, providing analgesia to the anterior abdominal wall.[9] It has been shown to be effective in adult patients undergoing lower abdominal surgery, offering improved postoperative pain scores and reduced opioid consumption compared to traditional pain management strategies.[10] The TAPB targets the fascial plane between the internal oblique and transversus abdominis muscles, providing somatic analgesia to the abdominal wall. In contrast, the QLB affects a broader range of nerves, including those responsible for both somatic and visceral pain, by injecting near the quadratus lumborum muscle.[11] Despite QLB being primarily studied in adult populations, its application is gaining interest in pediatric patients due to its potential for reducing postoperative pain.[12]

Although, both QLB and TAPB are frequently employed in pediatric anesthesia, evidence to guide clinical decisions on which block offers superior outcomes needs to be comprehensively reviewed. We aimed to directly compare the effect of the two truncal blocks, QLB and TAPB, on the quality of postoperative analgesia in terms of effective analgesia in children undergoing lower abdominal surgeries.

# Methods

This systematic review and meta-analysis was done in adherence to the PRISMA guidelines.[13] No specific ethical approval was required for this meta-analysis. This study was registered on Prospero (No. CRD42024579129).

## Search Strategy

Our search strategy was designed to identify full-text primary studies that evaluated the analgesic efficacy of QLB and TAPB in pediatric patients. We systematically searched PubMed, Scopus, Web of Science, and Cochrane Library databases from the inception date until August 2024, using our search terms shown in Table S1. No language restriction was applied. We also manually reviewed the reference list of eligible studies to identify any further relevant studies.

## Eligibility Criteria

All authors developed and agreed upon the inclusion and exclusion criteria to ensure the inclusion of all relevant studies. We included only randomized controlled clinical trials (RCTs) comparing the postoperative analgesic effect of QLB and TAPB in pediatric patients undergoing lower abdominal surgeries. We excluded (1) studies with adult patients; (2) trial registry records or clinical trial protocols; (3) reviews; (4) abstracts; (5) case reports; (6) letters and editorials; (7) and observational studies.

## Study Selection, Data Extraction, and Outcomes

Titles and abstracts of all studies were independently screened by two authors. Full-text articles were obtained for a more detailed assessment of their eligibility. Any conflict was resolved by a third author. The same authors then independently extracted the data using an Excel sheet. The information extracted from each study included study characteristics, population characteristics, details of primary and secondary outcomes, and complications.

The primary outcome was postoperative pain measured by the FLACC (Face, Legs, Activity, Cry, Consolability) score at 30 min, 1, 2, 4, 6, 8, 12, and 24 h. Secondary outcomes were the number of patients who needed rescue analgesic administration, parent satisfaction score, paracetamol consumption post-operatively, time for first analgesic requirements, postoperative nausea and vomiting (PONV), and heart rate (HR) after 30 min of anesthesia induction.

## Quality Assessment

The methodological quality of the included studies was assessed using the Cochrane risk-of-bias tool for randomized controlled trials (ROB-2).[14] Two authors independently conducted the methodological assessment. A third author was consulted to resolve any disagreements. The ROB-2 tool focused on five main domains: bias arising from the randomization process, bias due to deviations from the intended interventions, bias due to missing outcome data, bias in the measurement of the outcome, bias in the selection of the reported results, and the overall bias. The judgment for each domain could be low, some concern, or high.

## Certainty of Evidence

The quality of evidence was graded according to GRADE (Grading Recommendations, Assessment, Development and Evaluations). Randomized studies were initially graded as high by default and were downgraded or upgraded based on specified criteria. Criteria to downgrade included study limitations, risk of bias, inconsistency, indirectness, imprecision, and other biases. Criteria to upgrade the certainty of evidence included a large magnitude of effect and attenuation by plausible confounding factors. Evidence for each outcome was graded as high, moderate, low, or very low.

## Statistical Analysis

Statistical analysis was conducted using Review Manager version 5.4 software (The Cochrane Collaboration, Copenhagen, Denmark). We presented the pooled results of the continuous variable using the mean difference (MD) and standardized mean difference (SMD) using the generic inverse variance test with 95% CI and dichotomous variables using odds ratio (OR) by the Mantel-Haenszel test. We used a random effects model for all analyses. The statistical heterogeneity was tested using the chi-square and the $I^2$ statistic. If $I^2$ was greater than 50%, the heterogeneity was considered substantial, while if $I^2$ was greater than 90%, the heterogeneity was considered major. A P-value less than 0.05 was considered statistically significant. We did not evaluate the risk of publication bias because the total number of eligible studies for individual results did not exceed ten.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# Results

## Search Result

Our systematic search retrieved 271 papers from four electronic databases. 107 duplicate papers were removed, and 164 papers remained. After screening by title and abstract, 149 papers were excluded. We evaluated the full texts of the remaining 15 studies for final eligibility. Finally, nine papers were included in our meta-analysis. The study selection process is shown in (Figure 1).

## Summary of Included Studies and Risk of Bias

All nine studies were RCTs published between 2017 and 2024. A total of 584 pediatric patients aged 5 months to 9 years were included across the nine studies. Five studies were conducted in Turkey,[8,15–18] two in Egypt,[19,20] one in China,[12] and one in India.[21] Study characteristics are summarized in Table 1. Risk of bias was assessed and is shown in (Figure 2); all studies were of high quality with low risk of bias, which indicates reliable results.

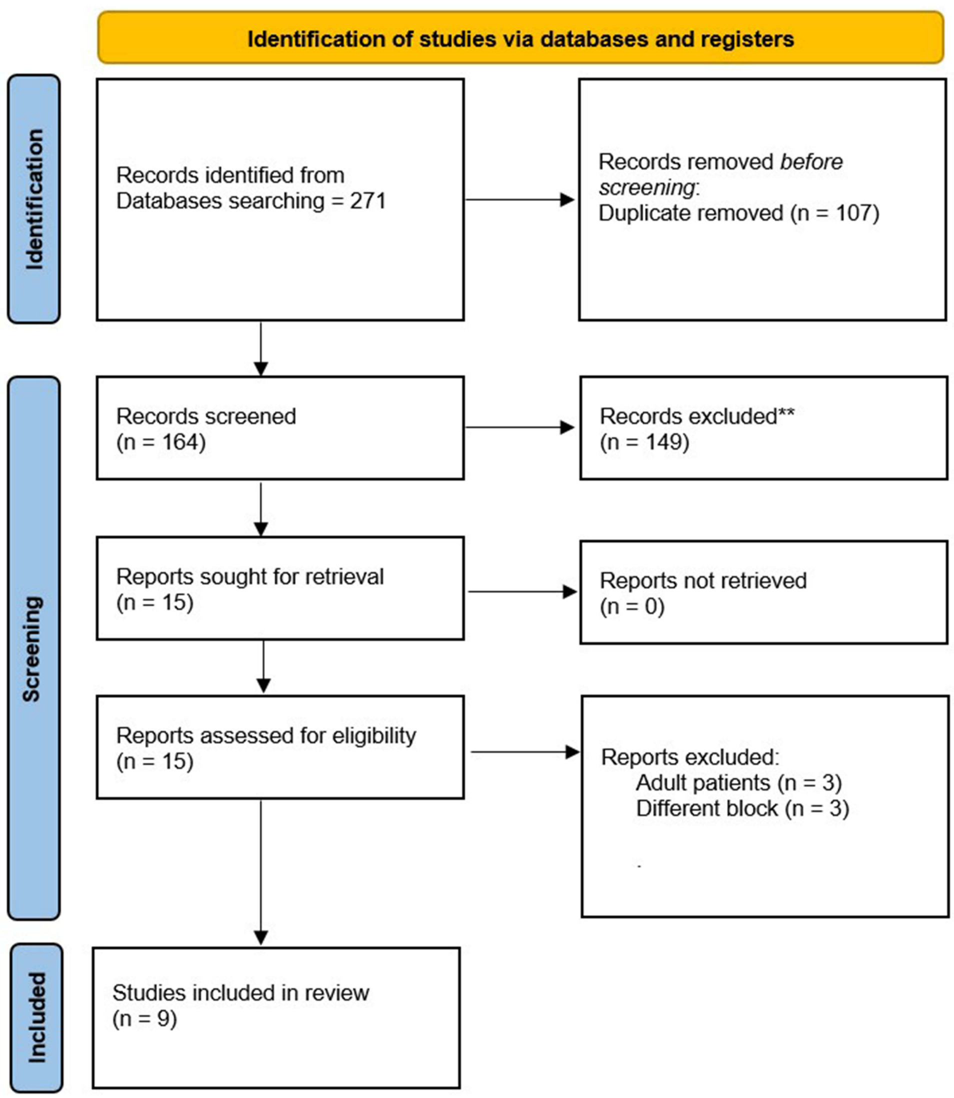


**Figure 1** PRISMA flow chart.

**Table 1** Summary of the Included Studies

| Study | Country | Design | Number of Patient in Each Group | Age (Mean ± SD) | Types and Doses of Local Anesthetics | QLB Approach | Surgery |
|---|---|---|---|---|---|---|---|
| Zhang et al 2022[12] | China | RCT | QLB: 60<br>TAPB: 60 | QLB: 6.3 ± 2.4<br>TAPB: 6.4 ± 2.4 | QLB:1 mL/kg ropivacaine 0.20%<br>TAPB: 1 mL/kg ropivacaine 0.20% | Posterior QLB (type 2) | Laparoscopic orchiopexy, hydrocelectomy, inguinal hernia, appendectomy |
| Sayin et al 2022[15] | Turkey | RCT | QLB: 30<br>TAPB:30 | QLB: 0.4 ± 0.2<br>TAPB: 0.5 ± 0.2 | QLB:0.3 mL/kg bupivacaine 0.25%<br>TAPB: 0.3 mL/kg bupivacaine 0.25% | Posterior QLB (type 2) | Inguinal Hernia Surgery |
| Öksüz et al 2017[8] | Turkey | RCT | QLB: 25<br>TAPB: 25 | QLB: 3.1 ± 0.2<br>TAPB: 3 ± 1.8 | QLB:0.5 mL/kg bupivacaine 0.20%<br>TAPB: 0.5 mL/kg bupivacaine 0.20%. | Posterior QLB (type 2) | Inguinal hernia repair, orchiopexy surgery |
| Mutlu et al 2023[16] | Turkey | RCT | QLB: 45<br>TAPB: 45 | QLB: 4.1 ± 1.2<br>TAPB: 3.7 ± 1.1 | QLB:0.4 mL/kg bupivacaine 0.25%<br>TAPB: 0.4 mL/kg bupivacaine 0.25% | Lateral QLB (type 1) | Orchiopexy surgery |
| Mansour et al 2024[19] | Egypt | RCT | QLB: 30<br>TAPB: 30 | QLB: 4 ± 1.5<br>TAPB: 4.3 ± 1.4 | QLB:0.5 mL/kg bupivacaine 0.25%<br>TAPB: 0.5 mL/kg bupivacaine 0.25% | Transmuscular QLB (type 3) | Lower abdominal laparoscopic surgery |
| İPEK et al 2019[17] | Turkey | RCT | QLB: 35<br>TAPB: 29 | QLB: 3.9 ± 3.3<br>TAPB: 4.2 ± 2.6 | QLB:0.5 mL/kg bupivacaine 0.25%<br>TAPB: 0.5 mL/kg bupivacaine 0.25% | Lateral QLB (type 1) | Inguinal hernia repair, orchiopexy, and hydrocelectomy |
| Ellatif et al 2020[20] | Egypt | RCT | QLB: 17<br>TAPB: 17 | QLB: 9.1±2.1<br>TAPB: 9±2 | QLB: 0.5 mL/kg of 0.25% levobupivacaine<br>TAPB: 0.5 mL/kg of 0.25% levobupivacaine | Posterior QLB (type 2) | Laparoscopic appendectomy |
| Anbu et al 2024[18] | Turkey | RCT | QLB: 33<br>TAPB: 33 | QLB: 3.3 ± 1.7<br>TAPB: 3.1 ± 1.4 | QLB:0.5 mL/kg bupivacaine 0.25%<br>TAPB: 0.5 mL/kg bupivacaine 0.25% | Posterior QLB (type 2) | Inguinal hernia repair, orchiopexy, orchiectomy, Processus vaginalis sac ligation |
| Priyadarshini et al 2022[21] | India | RCT | QLB: 20<br>TAPB: 20 | QLB: 3.5 ± 5.7<br>TAPB: 4 ± 5.7 | QLB:0.4 mL/kg ropivacaine 0.25%<br>TAPB: 0.4 mL/kg ropivacaine 0.25% | Lateral QLB (type 1) | Inguinal hernia repair |

**Abbreviations**: SD, standard deviation; RCT, randomized controlled clinical trials; QLB, quadratus lumborum block; TAPB, transversus abdominis plane block.

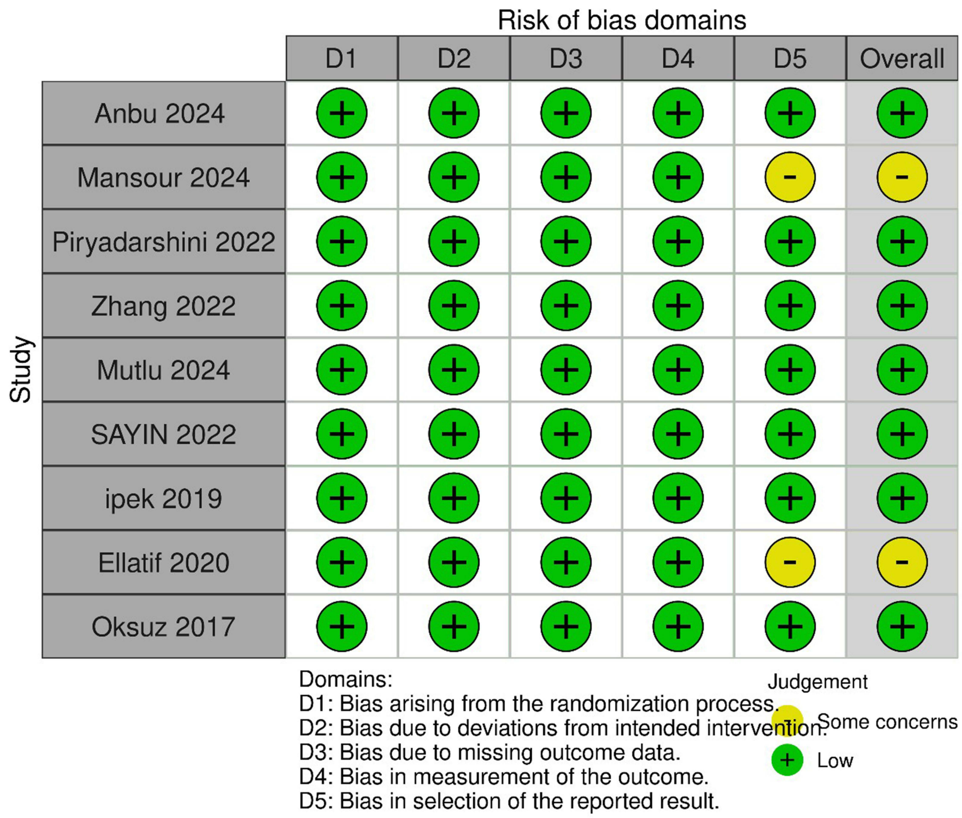


**Figure 2** Risk of bias assessment of the included studies.

# Outcomes

## FLACC Score

Postoperative pain was assessed using the FLACC score. The scores for each patient were taken for face, legs, activity, cry, and consolability. The FLACC score was reported postoperatively at 30 min, 1, 2, 4, 6, 8, 12, and 24 h. The overall pooled results indicate that QLB was significantly associated with less postoperative pain compared to TAPB (MD: −0.37; 95% CI: −0.51, −0.23; $P < 0.00001$). Based on the subgroup analysis, the FLACC score at 30 min, 1, 2, 4, and 6 h postoperatively was significantly lower in the QLB group compared to the TAPB group, with P values of 0.05, 0.003, 0.00001, 0.008, and 0.05, respectively. However, the FLACC score at 8, 12, and 24 h postoperatively were not statistically significant, with P values of 0.91, 0.07, and 0.58, respectively. Overall, a substantial heterogeneity was observed among the studies ($I^2 = 82\%$, $P < 0.00001$) (Table 2).

## Rescue Analgesic Requirement

The number of patients who requested or required postoperative analgesics was reported in eight studies[8,12,15–19,21] with 546 patients. Compared with TAPB, patients in the QLB group significantly required less rescue analgesic administration (OR: 0.25; 95% CI, 0.13, 0.49; $P < 0.0001$) (Figure 3). There was a substantial heterogeneity among the studies ($I^2 = 53\%$, $P = 0.04$).

## Parent Satisfaction Score

The satisfaction levels of the parents were given based on the postoperative outcomes. Six studies[8,12,16,18–20] assessed the satisfaction scores with 420 parents. Parents of the QLB group were significantly more satisfied with the postoperative outcome compared with the parents of the TAPB (SMD: 0.78; 95% CI: 0.53, 1.02; $P < 0.00001$) (Figure 4). No clinically significant heterogeneity was observed among the studies ($I^2 = 31\%$, $P = 0.20$).


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**Table 2** Pooled Results of FLACC Score

| FLACC Score at | Numbers of Studies | Numbers of Patients | MD (95% CI) | $I^2$ | P-value |
|---|---|---|---|---|---|
| 30 min | 5 | 386 | –0.43 (–0.86, 0.00) | 86% | 0.05 |
| 1h | 5 | 380 | –0.29 (–0.47, –0.10) | 19% | 0.003 |
| 2h | 5 | 326 | –0.51 (–0.72, –0.30) | 39% | <0.00001 |
| 4h | 4 | 296 | –0.79 (–1.37, –0.21) | 91% | 0.008 |
| 6h | 4 | 260 | –0.60 (–1.18, –0.01) | 78% | 0.05 |
| 8h | 3 | 246 | 0.05 (–0.89, 0.99) | 94% | 0.91 |
| 12h | 4 | 290 | –0.47 (–0.97, 0.03) | 72% | 0.07 |
| 24h | 5 | 356 | –0.06 (–0.27, 0.15) | 64% | 0.58 |
| Overall pooled results | - | - | –0.37 (–0.51, –0.23) | 82% | <0.00001 |

**Abbreviations**: FLACC, Face, Legs, Activity, Cry, Consolability Scale; MD, mean difference; CI, confidence interval; $I^2$, heterogeneity; min, minute; h, hour.

## Time for the First Analgesic Requirement

The time for the first postoperative analgesic requirement was reported in five studies[12,15,17,19,20] with 338 patients. Compared with the TAPB group, patients in the QLB group stayed significantly longer without the need for rescue analgesic administration (MD: 1.04; 95% CI: 0.38, 1.71; P = 0.002) (Figure S1). Major heterogeneity was observed among the studies ($I^2$ = 98%, P < 0.00001).

## Postoperative Paracetamol Consumption

Paracetamol was used to control the pain after the surgery was completed. Compared with TAPB, patients in the QLB group significantly consumed less paracetamol during the first 24 h postoperatively (SMD: −1.40; 95% CI: −2.43, −0.36; P = 0.008) (Figure S2). Substantial heterogeneity among the studies was observed ($I^2$ = 90%, P < 0.00001).

## PONV

The incidence of PONV between the QLB group and the TAPB group showed no statistically significant difference was found between the two groups (OR: 0.62; 95% CI: 0.22, 1.74; P = 0.37) (Figure S3). No heterogeneity was observed among the studies ($I^2$ = 0%, P = 0.59).

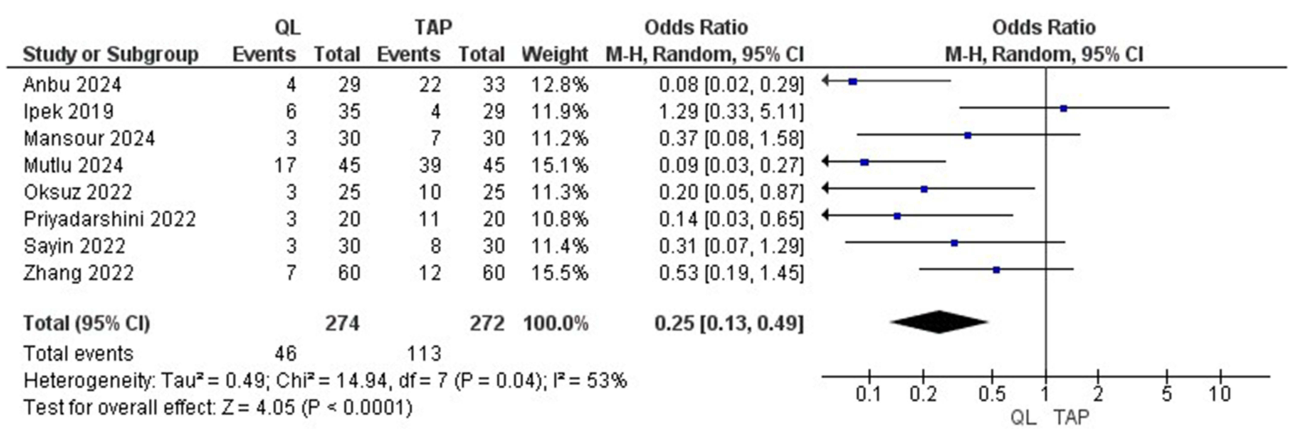


**Figure 3** Forest plot of rescue analgesic requirement.

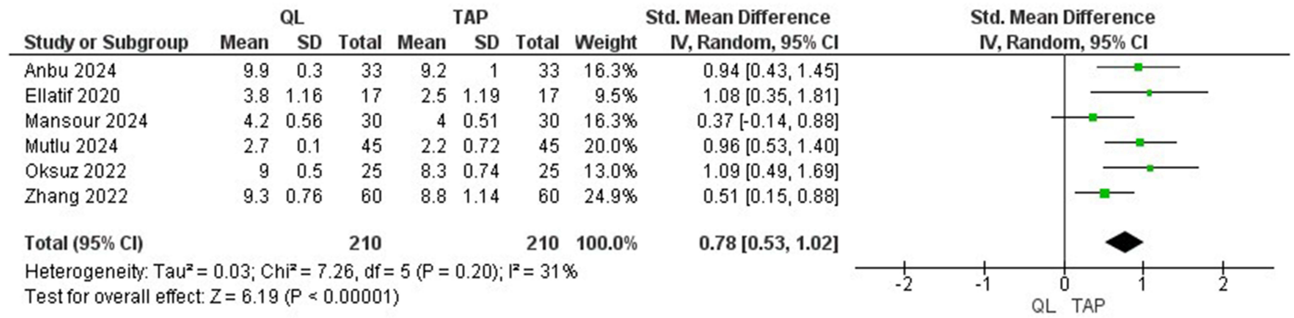


**Figure 4** Forest plot of parent satisfaction score.

### Heart Rate (HR) After 30 min of Anesthesia Induction

HR of the patients after 30 min following the anesthesia induction was similar among the two groups with no statistically significant difference (MD: −0.39, 95% CL: −3.29, 2.50; P = 0.79) (Figure S4). No clinically significant heterogeneity was observed among the studies ($I^2$ = 0%, P = 0.92).

## Certainty of Evidence

According to the GRADE approach, the parent satisfaction score was of high quality. The other outcomes were judged moderate. GRADE assessment results indicate reliable and robust certainty. Detailed GRADE framework across domains and per outcome was reported in Table S2.

# Discussion

In agreement with existing evidence assessing the efficacy outcome using either the QLB or TAPB among pediatric patients undergoing lower abdominal surgeries, scientifically proven advice was required. Comparing QLB and TAPB is necessary because both techniques are frequently employed in pediatric anesthesia, but evidence to guide clinical decisions on which block offers superior outcomes is lacking. To achieve this, we analyzed available data that compare QLB and TAPB in the context of pediatric patients who underwent lower abdominal surgeries. Based on our meta-analysis, QLB was significantly superior to TAPB in pediatric patients. QLB provides lower pain scores on the FLACC scale, longer time required for first analgesics, reduced demand for rescue analgesia, and better parent satisfaction. However, no significant difference was found in terms of PONV and HR.

Findings from the recent studies potentiated the positive role of QLB by offering delayed necessity of 1st analgesia when compared with the TAP group, which is consistent with the present study. Blanco et al observed postoperative patients who received QLB intervention for up to 24 hours without any pain-related complaints, which aligns with our findings.[22] Another meta-analysis comparing QLB with TAPB in adult patients revealed statistically significant results in pain control till 24 hours after surgery favoring QLB over TAPB (MD = −0.65; 95% CI = −1.29 to − 0.02; p = 0.04).[10] An in-depth understanding of the QLB direction also greatly improved pain, with the anterior one as the best approach, followed by the lateral and posterior, but carries a risk of muscular weakness up to 65%, as fostered in a retrospective study.[23] In the same context, a single injection in the QL plane produced a profound analgesic effect for 24 h, reducing the need for opioids or other rescue analgesics.[24] In contrast, following the TAPB, patients requested analgesia multiple times, which might be associated with a shorter duration of TAPB.[25] Success stories of cesarean and renal surgeries via QLB, reported by many authors, further validate its efficacy in managing postoperative pain.[9,26] Similarly, we found that patients in the QLB group required significantly less rescue analgesia compared to those in the TAPB group.

Recent studies have demonstrated the superiority of QLB over TAPB, as QLB not only provides longer-lasting pain control but also covers a broader anatomical area.[10,27,28] Consistent with the literature, we found that the quadratus lumborum plane, in contrast to TAP, provides effective analgesia at higher spinal levels, thereby enhancing its position in the practical implications of surgical intervention. According to Gupta et al,[29] the ability to block neuronal firing at a higher spinal level of nerve origin (T7-L1) may strengthen the rationale behind effective pain control using the QL plane rather than the TAP. Blanco et al desensitized T7 to T12 dermatomes with QLB, but T10 to T12 after TAPB.[22] Another study by Carney et al found similar results, showing that a single injectable at the quadratus lumborum plane caused pain relief from T4 to L2.[30] The thoracolumbar fascia is highly innervated by sensory and sympathetic nerve fibers, and blocking these sympathetic afferents through a posterior QLB could potentially alter local circulation and autonomic tone, contributing to its analgesic effects.[31] Higher blood levels of an anesthetic agent identified following the TAPB with subsequent enhanced absorption and degradation of the drug than the QLB, which further reduces the effective drug concentration at the surgical site, could be a factor for less time of pain relief in TAPB, as reported by Murouchi et al.[32] Most of the included studies used 0.5 mL/kg of bupivacaine as the local anesthetic, with some using 0.4 mL/kg of ropivacaine. However, the maximum recommended doses for both bupivacaine and ropivacaine are generally around 2–3 mg/kg, with slight variations in the upper limits and dosage per kilogram, making these differences in dosage relatively insignificant.[32]

In order to provide the best care to pediatric patients, it's necessary to evaluate the postoperative pain. The FLACC scale has a high sensitivity and specificity in evaluating pain in pediatric patients.[33] Our meta-analysis showed that the FLACC scale was significantly lower in QLB than in the TAPB at 30 min, 1, 2, 4, and 6 h. Consistent with this, the FLACC score was also significantly lower for the QLB compared to the non-QLB approaches, as revealed by Park et al.[34] However, Park et al[34] reported no significant changes in the FLACC score at 2 and 4 hours, while our results showed a significant reduction in the FLACC score in the QLB group at these time points. Unlike Park et al's study,[34] a recent meta-analysis aligned the FLACC score results at 2h ($p = 0.001$) and 4h ($p = 0.04$) with our results at 2h ($p = 0.00001$) and 4h (0.008).[35] Updates from recent data also signified a lower FLACC score in the QLB when compared with the control.[36]

The statistical significance of the FLACC score in our study demonstrates a direct impact on the improved perception of postoperative pain, as evidenced by increased parental satisfaction (MD: 0.78; 95% CI: 0.53, 1.02; $P < 0.00001$). Interestingly, Park et al[34] and Wen-li et al[35] reported insignificant parental satisfaction despite having a statistically significant FLACC score. A recent RCT revealed that the QLB provides more satisfaction with postoperative analgesia than TAPB.[37] We observed that extending the painless period and reducing the hassle of repeated requests for analgesia leads to greater satisfaction among the parents. As a result, the risk of pain-related complications could be halted, with a marked reduction in pain and higher satisfaction.

Our analysis revealed insignificant results for PONV and HR in both groups, which aligns with the findings of Liu et al.[10] Contrary to this, Ashoor et al claimed hypotension, bradycardia, and hematoma due to QLB but lacked statistical correlation.[38] The literature presents that QLB-induced sympathetic block can result in hypotension and variable HR.[39] TAPB could lead to local site reactions; however, these cases are few and generally insignificant. Future studies could investigate the association between higher doses and the development of local site reactions.

There are several limitations in our study. The stated studies are still fewer than ten, which may pose hurdles in assessing publication bias for meta-analysis. Variations in age group, drug dosage, and choice may alter outcomes that must be weighed to ensure reliable results. High heterogeneity was observed in most outcomes. This heterogeneity could be attributed to various QLB techniques, such as types 1 and 2. In addition, types of surgery were different among the studies. We could not conduct subgroup analysis as few data were reported for each subgroup.

## Conclusion

QLB provides superior analgesia compared to TAPB in pediatrics undergoing lower abdominal surgeries. In addition, QLB provides higher parent satisfaction and reduced analgesic demand after the surgery. Further studies should investigate more about the hemodynamic parameters and PONV.

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## Disclosure

The authors declare that they have no competing interests.

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