ANESTHESIOLOGY

Postoperative Analgesic Effectiveness of Quadratus Lumborum Block for Cesarean Delivery under Spinal Anesthesia

A Systematic Review and Meta-analysis

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ABSTRACT

Background: Spinal morphine is the mainstay of postcesarean analgesia. Quadratus lumborum block has recently been proposed as an adjunct or alternative to spinal morphine. The authors evaluated the analgesic effectiveness of quadratus lumborum block in cesarean delivery with and without spinal morphine.

Methods: Randomized trials evaluating quadratus lumborum block benefits in elective cesarean delivery under spinal anesthesia were sought. Three comparisons were considered: spinal morphine *versus* spinal morphine and quadratus lumborum block; spinal morphine *versus* quadratus lumborum block; and no block or spinal morphine *versus* quadratus lumborum block. The two coprimary outcomes were postoperative (1) 24-h cumulative oral morphine equivalent consumption and (2) pain at 4 to 6 h. Secondary outcomes included area under the curve pain, time to analgesic request, block complications, and opioid-related side effects.

Results: Twelve trials (924 patients) were analyzed. The mean differences (95% CIs) in 24-h morphine consumption and pain at 4 to 6 h for spinal morphine *versus* spinal morphine and quadratus lumborum block comparison were 0 mg (–2 to 1) and –0.1 cm (–0.7 to 0.4), respectively, indicating no benefit. For spinal morphine *versus* quadratus lumborum block, these differences were 7 mg (–2 to 15) and 0.6 cm (–0.7 to 1.8), respectively, also indicating no benefit. In contrast, for no block or spinal morphine *versus* quadratus lumborum block, improvements of –18 mg (–28 to –7) and –1.5 cm (–2.4 to –0.6) were observed, respectively, with quadratus lumborum block. Finally, for no block or spinal morphine *versus* quadratus lumborum block, quadratus lumborum block improved area under the 48-h pain curve by –4.4 cm · h (–5.0 to –3.8), exceeding the clinically important threshold (3.96 cm · h), but no differences were observed in the other comparisons.

Conclusions: Moderate quality evidence suggests that quadratus lumborum block does not enhance analgesic outcomes when combined with or compared with spinal morphine. However, the block improves postcesarean analgesia in the absence of spinal morphine. The clinical utility of this block seems limited to situations in which spinal morphine is not used.

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EDITOR'S PERSPECTIVE

What We Already Know about This Topic

- Spinal morphine is the preferred technique for analgesia after cesarean delivery performed under spinal anesthesia
- Quadratus lumborum block may offer analgesic benefit, but it is unclear in which patients

What This Article Tells Us That Is New

- Quadratus lumborum block does not provide analgesic benefit when compared with or in addition to spinal morphine for postcesarean analgesia
- In patients who do not receive spinal morphine, quadratus lumborum block does offer analgesic and opioid consumption benefit

Spinal morphine is considered to be the standard of care for postoperative analgesia after elective cesarean delivery performed under spinal anesthesia,[1] providing effective, safe, and cost-efficient analgesia up to 12 h postoperatively.[2]

With the advent and recent proliferation of abdominal wall fascial plane blocks, including the relatively novel quadratus lumborum block,[3,4] investigators have reported that its use can improve postoperative pain relief when combined with[5,6] or used in place of spinal morphine,[7,8] after spinal anesthesia for cesarean delivery. The deposition of local anesthetic adjacent to the quadratus lumborum muscle not only treats the somatic pain associated with a Pfannenstiel incision but also spreads proximally to the paravertebral space[9,10] and may be advantageous in providing relief to the visceral component of postcesarean pain.[11,12] Nevertheless, the literature presents trials with multiple designs, where

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block benefits have been assessed in the presence, in the absence, or in comparison with spinal morphine, thereby precluding a clear understanding of the potential analgesic effectiveness of this block.

This systematic review and meta-analysis aims to define the postoperative analgesic effectiveness of the quadratus lumborum block in the setting of elective cesarean delivery. Specifically, we sought to evaluate the postoperative analgesic effectiveness and safety of adding the block to spinal anesthesia with and without spinal morphine for elective cesarean delivery. We designated cumulative postoperative opioid consumption (oral morphine equivalents) during the first 24-h time interval and rest pain scores at 4 to 6 h postoperatively as coprimary outcomes. Secondary outcomes included area under the curve rest pain scores, time to analgesic request, block complications, and opioid-related side effects.

Materials and Methods

The authors adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement guidelines in preparing this review.[13] Randomized, controlled trials that assessed postoperative pain severity and analgesic outcomes in cesarean delivery when quadratus lumborum block was administered (1) in the presence or (2) in the absence of spinal morphine were evaluated using a predesigned protocol. The protocol (Supplemental Digital Content 1, http://links.lww.com/ALN/C505) was prospectively registered with the International Prospective Register of Systematic Reviews (CRD42020154035).

Eligibility Criteria

Randomized, controlled trials of adult parturients (18 yr or older) that evaluated the analgesic benefits of quadratus lumborum block in the setting of elective cesarean delivery performed under spinal anesthesia were eligible. We included all types of quadratus lumborum blocks (*i.e.*, anterior, posterior, and lateral). Trials were considered if patients were randomized to receive block and spinal anesthesia with or without spinal morphine. Trials that utilized combined spinal epidural techniques were also considered for inclusion. Studies were excluded if patients received exclusively epidural analgesia, procedures were nonelective, or continuous catheter-based block techniques were used. An online translator was used on any non-English articles. Because researchers have used different trial designs in evaluating the analgesic effectiveness of the quadratus lumborum block in cesarean delivery, we decided *a priori* to choose an approach that efficiently evaluates the evidence available. Our analysis was thus stratified according to the nature of regional anesthesia comparison performed, namely spinal morphine *versus* spinal morphine and quadratus lumborum block; spinal morphine *versus* quadratus lumborum block; and no block or spinal morphine *versus* quadratus lumborum block. The no block or no spinal morphine group comprised patients who received a spinal anesthetic with or without a short acting spinal opioid (*i.e.*, fentanyl and sufentanil). When necessary, the authors of potentially eligible trials were contacted for additional information such as research methodologies or additional data.

Search Methods for Identification of Studies

A systematic search strategy was created by an evidence-based medicine librarian for PubMed and Excerpta Medica Database to capture articles related to quadratus lumborum block and cesarean delivery (Supplemental Digital Content 2, http://links.lww.com/ALN/C506). The reference lists of all potentially eligible citations were also manually searched to identify additional trials that fulfilled inclusion criteria. Published abstracts from the following international meetings were also searched for eligible articles: American Society of Anesthesiologists 2011 to 2019, American Society of Regional Anesthesia and Pain Medicine 2013 to 2019, the European Society of Regional Anesthesia 2014 to 2019, the European Society of Anesthesiology 2015 to 2020, and the Society for Obstetric Anesthesia and Perinatology 2013 to 2019. The clinical trial registry (http://www.clinicaltrials.gov) and the Chinese Academic Full-text Database were also searched, and the authors of potentially relevant ongoing or completed trials were contacted for additional data.

Selection of Included Studies

Two independent reviewers (N.H. and M.Z.) initially screened the generated search results by title and abstract alone from inception to October 1, 2020. After this, a second round of screening was performed to evaluate the full-text versions of all potentially eligible citations against the inclusion criteria. Any disagreements on full-text eligibility were discussed until a consensus was reached. If a consensus could not be reached between the two reviewers, a third reviewer (F.A.) made the final decision.

Data Extraction

A standardized data extraction form[14] was created and used by two independent reviewers (N.H. and M.Z.) to extract data in duplicate. Any discrepancies in data extraction were discussed until a consensus was reached. If a consensus between the two reviewers could not be reached, a third reviewer (F.A.) made the final decision. The data extraction form collected information regarding the age of study participants; year of publication; nature and type of spinal anesthetic provided; block approach used and localization technique; block performance time with measures of variance; preoperative, intraoperative, and postoperative analgesic regimens; nature of primary and secondary outcomes studied; rest pain scores with measure of variance at all reported follow-up times; interval analgesic consumption

with measure of variance at all reported follow-up times; breakthrough analgesia requirement in recovery room; time to first analgesic request; level of patient satisfaction with pain relief; respiratory and functional outcomes; time to voiding; time to ambulation; time to breastfeeding; and all reported opioid-related side effects (*i.e.*, postoperative nausea and vomiting, excessive sedation, respiratory depression, pruritis, hypotension, and urinary retention) and block-related adverse events. Data were primarily gathered from tables of included studies. In cases of data reported graphically rather than numerically, the authors were contacted for additional information. If no response was obtained, outcome data were derived from the graphs using a graph digitizing software (GraphClick, Arizona Software, USA). The corresponding authors of abstracts or trials identified through http://www.clinicaltrials.gov included in the review were contacted for additional information on their methodology and/or outcome data.

Assessment of Methodologic Quality and Risk of Bias

Two independent reviewers (N.H. and T.W.) used the tool from The Cochrane Collaboration (London, United Kingdom) for risk of bias to evaluate the methodologic quality of all included trials in this review.[15] Questions in this tool relate to the methodology behind randomization, allocation, blinding, and reporting of outcome data, as well as loss to follow-up.[15] We decided *a priori* to assign a high risk of performance bias to studies that did not have a sham block group (invasive placebo) because of concerns of blinding of study participants and personnel.

The same independent reviewers also assessed the methodologic quality across the statistically pooled outcomes using the Grades of Recommendation, Assessment, Development, and Evaluation (GRADE)[16,17] guidelines. Any discrepancies in methodologic quality assessment were discussed until a consensus was reached. If a consensus between the two reviewers could not be reached, a third reviewer (F.A.) made the final decision.

Primary and Secondary Outcomes

The two coprimary outcomes of this meta-analysis were defined as (1) cumulative postoperative opioid consumption in oral milligram of morphine equivalents during the first 24-h time interval and (2) visual analog scale (VAS, 0 = no pain and 10 = worst pain imaginable) rest pain scores at 4 to 6 h postoperatively. The 4- to 6-h time interval was chosen to capture the worst pain after cesarean section as well as the peak effect of the quadratus lumborum block.[18] The 24-h time interval was chosen for oral morphine equivalent consumption because it potentially captures the maximal duration of the intervention examined (*i.e.*, quadratus lumborum block).

The secondary analgesic outcomes included difference in area under the curve of the weighted pooled rest pain scores at five predesignated time points (in recovery room [0 to 2 h], and at 4 to 6, 12, 24, and 48 h postoperatively); postoperative rest pain severity (VAS pain scores) in recovery room and at 4 to 6, 12, 24, and 48 h postoperatively; time to first analgesic request (hours); requirement for breakthrough analgesia in recovery room; any indicators of postoperative function and quality of recovery such as time to ambulation (hours), time to voiding (hours), time to breastfeeding (hours); patient satisfaction with pain relief; and block performance time (minutes). Secondary safety outcomes included opioid-related side effects (*i.e.*, postoperative nausea and vomiting, excessive sedation, respiratory depression, pruritis, hypotension, and urinary retention) and block-related complications[19] (*i.e.*, hematoma, organ injury, local anesthetic systemic toxicity, and block failure).

Measurement of Outcome Data

For the first coprimary outcome, cumulative postoperative opioid consumption during the first 24-h time interval, all opioids were converted to oral milligram of morphine equivalents.[20] For the second coprimary outcome, rest pain severity at 4 to 6 h postoperatively, all postoperative pain data were converted to an equivalent 0 to 10–point VAS score (0 = no pain, 10 = worst pain imaginable) by the methods described by Thorlund *et al.*[21] For our secondary pain outcomes, all data were also expressed on an equivalent 0 to 10–point VAS score.[21] Measures of patient satisfaction were converted to equivalent VAS score (0 = least satisfied, 10 = most satisfied).[21] Finally, all time-to-event data were presented in hours, unless otherwise specified.

Statistical Analyses

The mean and SD were sought and extracted for continuous outcome data. The mean was approximated using the median and interquartile range if its value was not provided.[22] When a mean and CI were reported, these were statistically converted to a mean and SD *via* the methods described by Wan *et al.*[22] and the Cochrane Collaboration.[23] However, if an SD was unobtainable by the above methods, the value was imputed.[24] When needed, dichotomous outcome data were converted to continuous data to allow for statistical pooling.[25] For dichotomous outcome data associated with (1) requirement for breakthrough analgesia in recovery room and (2) safety (*i.e.*, opioid-related side effects and block-related complications), results data were converted to overall incidence numbers.

Meta-analysis

For the purposes of this review, we pooled data for an outcome when data were available from at least two trials. In situations in which dichotomous data could be pooled, a meta-analysis was performed using the Mantel–Haenszel random-effects model because we expected clinical heterogeneity between the included studies. For continuous

outcome data, the data were weighted according to the inverse variance method and pooled using a random-effects model.[26] For the coprimary outcomes of this review (*i.e.*, opioid consumption at 24 h and rest pain severity at 4 to 6 h postoperatively), the weighted mean difference with a 95% CI was calculated. We designated a P value less than 0.025 as a threshold of statistical significance for the two coprimary outcomes to reduce the risk of multiple testing bias.

For difference in area under the curve of the weighted pooled rest pain scores, the mean difference in area under the curve with 99% CI of the pooled rest pain scores was calculated. For the remaining continuous secondary outcomes, a weighted mean difference with 99% CI was calculated. For dichotomous secondary outcomes, an odds ratio with a 99% CI was calculated. We decided to use the 99% CI for all secondary outcomes to account for the smaller number of studies pooled and the potential risk of multiple testing bias. We *a priori* adjusted the threshold for statistical significance for the pooled secondary outcomes in each of the three comparisons performed using the Bonferroni–Holm correction (P_c, corrected threshold of statistical significance) to account for the several secondary outcomes analyzed.[27]

Interpretation of Area under the Curve Analysis

Our area under the curve analysis of the pooled rest pain scores was interpreted in light of the minimal clinically important difference of the VAS rest pain score. For cesarean delivery, the minimal clinically important difference in VAS pain scores has been estimated to be 0.99 cm on a 0 to 10–point VAS pain scale score.[28] Because we planned to include five time points (*i.e.*, 0 to 2, 4 to 6, 12, 24, and 48 h) in our area under the curve analysis, we used an adjusted value of 3.96 cm · h. If four time points were included in the area under the curve analysis (0 to 2, 4 to 6, 12, and 24 h), we used an adjusted value of 2.97 cm · h. Clinical equivalence was presumed if the mean difference within a comparison did not cross the 3.96-cm · h or 2.97-cm · h margin.

Assessment of Heterogeneity

An I^2 statistic test was used to assess heterogeneity. We considered an I^2 greater than 50% to indicate significant heterogeneity, as recommended by the Cochrane Handbook for Systematic Reviews.[23] If heterogeneity was above our predefined cut-off, metaregression was performed using mixed modeling to explore whether our primary outcomes results were influenced by *a priori* specified clinical predictors of the treatment effect. Metaregression was performed only if at least four studies were included in an estimate of effect and each group within the covariate included at least two randomized, controlled trials. The metaregression analysis examined the following covariates: (1) block approach (lateral, posterior, or anterior)[29,30]; (2) block localization (ultrasound *vs.* landmark *vs.* paresthesia *vs.* nerve stimulator)[31,32]; (3) short-/intermediate-acting (lidocaine and mepivacaine) *versus* long-acting (bupivacaine, levobupivacaine, and ropivacaine) local anesthetics[33]; (4) local anesthetic dose in block (converted to milligrams of bupivacaine)[34]; (5) local anesthetic volume in block (milliliters); (6) local anesthetic dose in spinal anesthetic (converted to milligrams of bupivacaine)[34]; (7) type of short-acting narcotic used in spinal anesthetic (fentanyl *vs.* sufentanil *vs.* cocaine *vs.* none); (8) dose of long-acting narcotic used in spinal anesthetic (micrograms); (9) type of spinal anesthetic used (combined spinal epidural *vs.* single-injection spinal anesthetic); and (10) postoperative analgesic modality (multimodal = combines opioid and other adjuvants *vs.* unimodal = uses opioids only).[35,36]

Assessment of Publication Bias

A funnel plot was generated and examined for publication bias in each of the outcomes assessed. In the absence of bias, the plot should look like a symmetrical, inverted funnel.[23] Furthermore, for all primary outcomes, we evaluated publication bias using the Egger Regression test when at least three randomized, controlled trials were included in the estimate of effect.[37]

Data Management

All forest and funnel plots were generated using Review Manager Software (RevMan version 5.2; Nordic Cochrane Center, Cochrane Collaboration). Metaregression was performed using Comprehensive Meta-Analysis 3.0 (Engelwood, USA).

Results

The initial search strategy identified 77 unique citations. Further search of the gray literature (Chinese Academic Full-text Database) yielded two[38,39] potentially eligible citations, and an additional three[40–42] were identified through correspondence with the authors of completed and ongoing trials registered on http://www.clinicaltrials.gov. These three trials[40–42] were subsequently published in the form of abstracts[40,41] and a full-text article.[42] After extensive review of individual title and abstracts alone of the 82 citations, a total of 66 were excluded because of nonrandomization (n = 56), incorrect intervention (n = 6), and incorrect study population (n = 4). The remaining 16 citations had their full-text versions retrieved for evaluation of eligibility. Of these, four were excluded because of nonrandomization[43] and incorrect comparison.[3,29,44] Thus, 12 full-text, randomized, controlled trials[4–8,38–42,45,46] were included in this systematic review and meta-analysis. Supplemental Digital Content 3 (http://links.lww.com/ALN/C507) depicts the study flow diagram in this review. After correspondence with authors of the included studies, authors of four trials[4–6,46] provided additional details regarding methodology, and authors of three trials provided additional data that were subsequently confirmed when their work was published in the form of an abstract[40,41] or full article.[42] Only one study[7] required data extraction using GraphClick.

Study Characteristics

The study characteristics and outcomes assessed in this review are presented in table 1. All 12 randomized trials[4–8,38–42,45,46] included adult parturients undergoing elective cesarean delivery under spinal anesthesia. The included studies encompassed 924 patients. Of those, 219 received spinal morphine,[5–7,40–42] 132 received spinal morphine and quadratus lumborum block,[5,6,40,42] 324 received quadratus lumborum block (without spinal morphine),[4,5,7,8,38–41,45,46] and 249 did not receive a block or spinal morphine.[4,5,7,8,38,39,45,46] The comparisons involved included four studies (n = 263 patients)[5,6,40,42] comparing spinal morphine with spinal morphine and quadratus lumborum block; four studies (n = 296 patients)[5,7,40,41] comparing spinal morphine with quadratus lumborum block; and eight studies (n = 498 patie nts)[4,5,7,8,38,39,45,46] comparing no block or spinal morphine with quadratus lumborum block. A total of 11 studies[4–6,8,38–42,45,46] reported cumulative opioid consumption during the first 24-h time interval (first coprimary outcome), and all 12 studies[4–8,38–42,45,46] reported rest pain severity at 4 to 6 h postoperatively (second coprimary outcome). Postoperative functional outcomes were measured by four studies,[7,8,41,46] and five studies[4–6,42,46] assessed block-related complications.

The nerve block techniques and analgesic regimens used in the included studies are presented in table 2. All studies performed the quadratus lumborum block immediately postcesarean delivery and used various techniques for local anesthetic deposition. Specifically, three studies[4,38,46] injected local anesthetic at the lateral border of the quadratus lumborum (quadratus lumborum block type I), six[5–7,39,42,45] injected at the posterior border (quadratus lumborum block type II), and two[8,41] injected at the anterior border (quadratus lumborum block type III); one study[40] did not explicitly describe the site of local anesthetic deposition. All twelve studies[4–8,38–42,45,46] used ultrasound guidance for block localization. The type, concentration, and volume of local anesthetic used also varied. Although all studies[4–8,38–42,45,46] used long-acting local anesthetics, three studies[41,42,45] used bupivacaine-containing solutions (0.125 to 0.25%), eight studies[4,5,7,8,38–40,46] used ropivacaine-containing solutions (0.2 to 0.375%), and one study[6] used a levobupivacaine-containing solution (0.25%). The volume of local anesthetic solution injected ranged from 28 ml to 60 ml, and no study reported using adjuvants (*i.e.*, epinephrine, dexmedetomidine, clonidine).[4–8,38–42,45,46]

The risk of bias assessment for each included study is depicted in Supplemental Digital Content 4 (http://links.lww.com/ALN/C508).

Primary Outcomes

Cumulative 24-h Oral Milligrams of Morphine Equivalent Consumption. For spinal morphine *versus* spinal morphine and quadratus lumborum block, results from four trials[5,6,40,42] (n = 241: spinal morphine = 120, spinal morphine and quadratus lumborum block = 121) were pooled. Overall, both modalities did not differ in analgesic consumption at 24 h, with a weighted mean difference (95% CI) of 0 mg (−2 to 1; $P = 0.450$; fig. 1A). This analysis was characterized by a low level of heterogeneity ($I^2 = 0\%$, $P = 0.522$) and, as such, metaregression analysis was not conducted. The risk for publication bias was low for this comparison ($P = 0.669$), and the overall GRADE quality of evidence was rated as high.

For spinal morphine *versus* quadratus lumborum block, results from three trials[5,40,41] (n = 222: spinal morphine = 111, quadratus lumborum block = 111) were pooled. Overall, both modalities did not differ in analgesic consumption at 24 h, with a weighted mean difference (95% CI) of 7 mg (−2 to 15; $P = 0.146$; fig. 1B). This analysis was characterized by a high level of heterogeneity ($I^2 = 55\%$, $P = 0.113$); however, metaregression analysis could not be performed as there were fewer than four studies included in the estimate of effect. Our results were robust to sensitivity analysis for (1) type of short-acting narcotic used in spinal anesthetic (sufentanil[41]) and (2) postoperative analgesic modality (multimodal[5]); however, excluding the study that did not[40] specify the block approach significantly changed estimate of effect in favor of lower analgesic consumption at 24 h with spinal morphine. All studies[5,40,41] included in this analysis (1) used long-acting local anesthetics, (2) used ultrasound guidance for block placement, and (3) performed a spinal anesthetic. The risk for publication bias was low for this comparison ($P = 0.695$), and the overall GRADE quality of evidence was rated as moderate owing to heterogeneity in the pooled estimate.

For no block or spinal morphine *versus* quadratus lumborum block, results from seven trials (n = 418: no block or spinal morphine = 210, quadratus lumborum block = 208) were pooled.[4,5,8,38,39,45,46] Measured in oral milligrams of morphine equivalents, the mean (SD) oral morphine equivalent consumption was 67 mg (54 mg) and 47 mg (40 mg) in the no block or spinal morphine and quadratus lumborum block groups, respectively. The weighted mean difference (95% CI) was found to favor quadratus lumborum block by −18 mg (−28 to −7; $P = 0.001$; fig. 1C). This analysis was characterized by a high level of heterogeneity ($I^2 = 95\%$, $P < 0.00001$), and metaregression analysis was performed to explore sources of heterogeneity using *a priori* defined covariates. An interaction could not be identified between 24-h milligrams of oral morphine equivalent consumption and (1) local anesthetic dose in block ($P = 0.667$), (2) local anesthetic volume in block ($P = 0.451$), (3) local anesthetic dose in spinal anesthetic ($P = 0.278$), (4) type of short-acting narcotic used in spinal anesthetic (fentanyl[4,5,45] *vs.* sufentanil[8,46] *vs.* none[38,39]; $P = 0.239$), or (5) postoperative analgesic modality (multimodal[4,5,8,45,46] *vs.* unimodal[38,39]; $P = 0.481$). Metaregression analysis could not be performed for the remaining covariates, because there were fewer than two studies per subgroup because all studies[4,5,8,38,39,45,46] included in this analysis (1) used long-acting

Table 1. Study Characteristics and Outcomes of Interest Assessed in Included Studies

Groups (n)	N	Surgical Anesthesia	Primary Outcome	Rest Pain Scores		Dynamic Pain Scores		Opioid Consumption		Time to First Analgesic Request	Opioid-related Adverse Effects	Block-related Complications	Patient Satisfaction	Duration of Recovery Room Stay Time	Hospital Discharge Time	Respiratory Outcomes	Functional Outcomes	Block Success	Author/Year
				Early	Late	Early	Late	Early	Late										
Spinal morphine *vs.* spinal morphine and quadratus lumborum block																			
1. Spinal morphine + quadratus lumborum block (45)	90	Spinal	Opioid consumption	•	•	•	•	•	•		•	•			•				Irwin 2019
2. Spinal morphine (45)																			
1. Spinal morphine + quadratus lumborum block (44)	176	Spinal	Pain scores	•		•		•			•	•							Tamura 2019
2. Spinal morphine (44)																			
3. Quadratus lumborum block (44)																			
4. No block or spinal morphine (44)																			
1. Spinal morphine + quadratus lumborum block (15)	43	Spinal	Opioid consumption	•	•	•		•			•		•						Ferreira 2020
2. Spinal morphine (13)																			
3. Quadratus lumborum block (15)																			
1. Spinal morphine + quadratus lumborum block (28)	75	Spinal	Not specified	•	•	•	•	•		•	•	•							Pangthipampai 2020
2. Spinal morphine (27)																			
3. Quadratus lumborum block (20)*																			
Spinal morphine *vs.* quadratus lumborum block																			
1. Spinal morphine (60)	120	Spinal	Opioid consumption	•				•			•		•			•	•		Felfel 2018
2. Quadratus lumborum block (60)																			
1. Spinal morphine (30)	90	Spinal	Integrated analgesia assessment score	•	•				•	•	•		•			•	•		Salama 2019
2. Quadratus lumborum block (30)																			
3. No block or spinal morphine (30)																			
1. Spinal morphine + quadratus lumborum block (44)	176	Spinal	Pain scores	•		•		•			•	•							Tamura 2019
2. Spinal morphine (44)																			
3. Quadratus lumborum block (44)																			
4. No block or spinal morphine (44)																			
1. Spinal morphine + quadratus lumborum block (15)	43	Spinal	Opioid consumption	•	•	•		•			•		•						Ferreira 2020
2. Spinal morphine (13)																			
3. Quadratus lumborum block (15)																			
No block or spinal morphine *vs.* quadratus lumborum block																			
1. Quadratus lumborum block (25)	50	Spinal	Opioid consumption	•	•	•	•	•	•		•								Blanco 2015
2. No block or spinal morphine (25)																			
1. Quadratus lumborum block (20)	40	Spinal	Opioid consumption	•	•	•	•	•	•		•	•					•		Krohg 2018
2. No block or spinal morphine (20)																			
1. Quadratus lumborum block (30)	60	Spinal	Opioid consumption	•	•			•	•	•	•	•							Mieszkowski 2018
2. No block or spinal morphine (30)																			

(*Continued*)

Table 1. (Continued)

Groups (n)	N	Surgical Anesthesia	Primary Outcome	Rest Pain Scores		Dynamic Pain Scores		Opioid Consumption		Time to First Analgesic Request	Opioid-related Adverse Effects	Block-related Complications	Patient Satisfaction	Duration of Recovery Room Stay Time	Hospital Discharge Time	Respiratory Outcomes	Functional Outcomes	Block Success	Author/Year
				Early	Late	Early	Late	Early	Late										
1. Quadratus lumborum block (35)	70	Spinal	Opioid consumption	•	•	•	•	•		•	•						•		Hansen 2019
2. No block or spinal morphine (35)																			
1. Spinal morphine (30)	90	Spinal	Integrated analgesia assessment score	•	•				•	•	•		•			•	•		Salama 2019
2. Quadratus lumborum block (30)																			
3. No block or spinal morphine (30)																			
1. Spinal morphine + quadratus lumborum block (44)	176	Spinal	Pain scores	•		•		•			•	•							Tamura 2019
2. Spinal morphine (44)																			
3. Quadratus lumborum block (44)																			
4. No block or spinal morphine (44)																			
1. Quadratus lumborum block (35)	70	Spinal	Opioid consumption	•	•			•		•	•								Wang 2019
2. No block or spinal morphine (35)																			

*Group received quadratus lumborum block without spinal anesthesia.
Early, less than or equal to 24 h; Late, more than 24 h; PACU, postanesthesia care unit.

local anesthetics, (2) used ultrasound guidance for block placement, and (3) did not use long-acting narcotic (*i.e.*, morphine) in the spinal anesthetic solution. Our results were also robust to sensitivity analysis for block approach (anterior quadratus lumborum injection[8]) and type of spinal anesthetic performed (combined spinal epidural[39]). The risk for publication bias was low for this comparison (P = 0.205), and the overall GRADE quality of evidence was rated as moderate because of heterogeneity in the pooled estimate.

Rest Pain Severity at 4 to 6 h Postoperatively. For spinal morphine *versus* spinal morphine and quadratus lumborum block, results from three trials[5,6,42] (n = 213: spinal morphine = 107, spinal morphine and quadratus lumborum block = 106) were pooled. Overall, both modalities did not differ in rest pain at 4 to 6 h postoperatively, with a weighted mean difference (95% CI) of −0.1 cm (−0.7 to 0.4; P = 0.510; fig. 2A). This analysis was characterized by a low level of heterogeneity (I^2 = 9%, P = 0.328) and, as such, metaregression analysis was not conducted. The risk for publication bias was low for this comparison (P = 0.769), and the overall GRADE quality of evidence was rated as high.

For spinal morphine *versus* quadratus lumborum block, results from three trials[5,7,41] (n = 254: spinal morphine = 128, quadratus lumborum block = 126) were pooled. Overall, both modalities did not differ in rest pain at 4 to 6 h postoperatively, with a weighted mean difference (95% CI) of 0.6 cm (−0.7 to 1.8; P = 0.259; fig. 2B). This analysis was characterized by a high level of heterogeneity (I^2 = 91%, P < 0.0001); however, metaregression analysis could not be performed because there were fewer than four studies included in the estimate of effect. Our results were robust to sensitivity analysis for (1) block approach (anterior quadratus lumborum injection[41]), (2) type of short-acting narcotic used in spinal anesthetic (sufentanil,[41] fentanyl,[5] and none[7]), and (3) postoperative analgesic modality (unimodal[41]). All studies[5,7,41] included in this analysis (1) used long-acting local anesthetics, (2) used ultrasound guidance for block placement, and (3) performed a spinal anesthetic. The risk for publication bias was low for this comparison (P = 0.376), and the overall GRADE quality of evidence was rated as moderate because of heterogeneity in the pooled estimate.

For no block or spinal morphine *versus* quadratus lumborum block, results from eight trials[4,5,7,8,38,39,45,46] (n = 478: no block or spinal morphine = 240, quadratus lumborum block = 238) were pooled. Overall, the weighted mean difference (95% CI) was found to favor quadratus lumborum block by −1.5 cm (−2.4 to −0.6; P < 0.00001; fig. 2C). This analysis was characterized by a high level of heterogeneity (I^2 = 92%, P < 0.00001), and metaregression analysis was performed to explore sources of heterogeneity using *a priori* defined covariates. An interaction was observed between pain scores at 4 to 6 h and (1) volume of local anesthetic used for block (P = 0.014) and (2) local anesthetic dose

Table 2. Details of Block Technique and Analgesic Regimens Used in Included Studies

		Quadratus Lumborum Block Characteristics				
Surgical Anesthetic Regimen	**Supplemental Postoperative Analgesia**	**Block technique:** 1. Injection at Lateral Border of Quadratus Lumborum 2. Injection at Posterior Border of Quadratus Lumborum 3. Injection at Anterior Border of Quadratus Lumborum	**Localization**	**Block Local Anesthetic Bolus**	**Sham Block Performed**	**Author/Year**
Spinal morphine *vs.* spinal morphine and quadratus lumborum block						
Spinal anesthesia: 10.0–11.5 mg hyperbaric bupivacaine, 20 μg fentanyl, 100 μg morphine	PCA morphine; 1 g oral paracetamol every 6 h; 75 mg oral diclofenac sodium every 12 h; 5 mg oral oxycodone after discontinuation of PCA	2	Ultrasound	40 ml 0.25% levobupivacaine	No	Irwin 2019
Spinal anesthesia: 11.0–12.5 mg hyperbaric bupivacaine, 10 μg fentanyl +/- 100 μg morphine	50 mg oral diclofenac sodium if pain score >3; 15 mg IV pentazocine if pain score 3–5.9; 15 mg/kg IV acetaminophen and 15 mg pentazocine if pain score >6; oral NSAID as needed	2	Ultrasound	0.45 ml/kg 0.3% ropivacaine (each side)	Yes	Tamura 2019
Spinal anesthesia: 12.5 mg hyperbaric bupivacaine, 20 μg fentanyl +/- 80 μg morphine	PCA morphine	Not specified	Ultrasound	40 ml 0.375% ropivacaine	Not applicable	Ferreira 2020
Spinal anesthesia: 10 mg hyperbaric bupivacaine, 200 μg morphine	PCA morphine	2	Ultrasound	50 ml 0.25% bupivacaine	Not applicable	Pangthipampai 2020
Spinal morphine *vs.* quadratus lumborum block						
Spinal anesthesia: 10 mg hyperbaric bupivacaine, 5 μg sufentanil +/- 100 μg morphine	PCA morphine	3	Ultrasound	40 ml 0.125% bupivacaine	Not applicable	Felfel 2018
Spinal anesthesia: 12.5 mg hyperbaric bupivacaine +/- 100 μg morphine	PCA morphine; 1 g IV paracetamol; 1 g IV paracetamol as needed; rectal 100 mg diclofenac	2	Ultrasound	48 ml 0.375% ropivacaine	Yes	Salama 2019
Spinal anesthesia: 11.0–12.5 mg hyperbaric bupivacaine, 10 μg fentanyl +/- 100 μg morphine	50 mg oral diclofenac sodium if pain score >3; 15 mg IV pentazocine if pain score 3–5.9; 15 mg/kg IV acetaminophen and 15 mg pentazocine if pain score >6; oral NSAID as needed	2	Ultrasound	0.45 ml/kg 0.3% ropivacaine (each side)	Yes	Tamura 2019
Spinal anesthesia: 12.5 mg hyperbaric bupivacaine, 20 μg fentanyl +/- 80 μg morphine	PCA morphine	Not specified	Ultrasound	40 ml 0.375% ropivacaine	Not applicable	Ferreira 2020
No block or spinal morphine *vs.* quadratus lumborum block						
Spinal anesthesia: 15 mg hyperbaric bupivacaine, 20 μg fentanyl	PCA morphine; 1 g oral paracetamol every 8 h; 100 mg oral ketoprofen every 8 h	2	Ultrasound	0.2 ml/kg 0.125% bupivacaine (each side)	Yes	Blanco 2015
Spinal anesthesia: 10 mg isobaric bupivacaine, 4 μg sufentanil	PCA ketobemidone, 1 g oral paracetamol every 6 h; 400 mg oral ibuprofen every 6 h	1	Ultrasound	0.4 ml/kg 0.2% ropivacaine (each side)	Yes	Krohg 2018
Spinal anesthesia: 12.5 mg hyperbaric bupivacaine, 20 μg fentanyl	1 g IV paracetamol; 5 mg subcutaneous morphine every 4 h as needed	1	Ultrasound	48 ml 0.375% ropivacaine	No	Mieszkowski 2018
Spinal anesthesia: 15 mg hyperbaric ropivacaine	PCA sufentanil; bolus epidural as needed	2	Ultrasound	60 ml 0.25% ropivacaine	No	Zhang 2018
Spinal anesthesia: 10 mg hyperbaric bupivacaine, 2.5 μg sufentanil	PCA morphine or oral morphine or oral oxycodone; 1 g oral paracetamol every 6 h; 400 mg oral ibuprofen every 8 h as needed	3	Ultrasound	60 ml 0.375% ropivacaine	Yes	Hansen 2019
Spinal anesthesia: 12.5 mg hyperbaric bupivacaine +/- 100 μg morphine	PCA morphine; 1 g IV paracetamol; 1 g IV paracetamol as needed; rectal 100 mg diclofenac sodium	2	Ultrasound	48 ml 0.375% ropivacaine	Yes	Salama 2019
Spinal anesthesia: 11.0–12.5 mg hyperbaric bupivacaine, 10 μg fentanyl +/- 100 μg morphine	50 mg oral diclofenac sodium if pain score >3; 15 mg IV pentazocine if pain score 3–5.9; 15 mg/kg IV acetaminophen and 15 mg pentazocine if pain score >6; oral NSAID as needed	2	Ultrasound	0.45 ml/kg 0.3% ropivacaine (each side)	Yes	Tamura 2019
Spinal anesthesia: 10 mg hyperbaric ropivacaine	PCA morphine	1	Ultrasound	48 ml 0.375% ropivacaine	Yes	Wang 2019

None of the included studies specified whether preincisional analgesia or block success was assessed. All blocks were performed postoperatively.

IV, intravenous; NSAID, nonsteroidal anti-inflammatory drug; PCA, patient-controlled analgesia.

in spinal anesthetic ($P = 0.001$). However, an interaction could not be identified between pain at 4 to 6 h and (1) local anesthetic dose in block ($P = 0.162$), (2) type of short-acting narcotic used in spinal anesthetic (fentanyl[4,5,45] *vs.* sufentanil[8,46] *vs.* none[7,38,39]; $P = 0.674$), or (3) postoperative analgesic modality (multimodal[4,5,7,8,45,46] *vs.* unimodal[38,39]; $P = 0.295$). Metaregression analysis could not be performed for the remaining covariates, because there were fewer than two studies per subgroup, because all studies[4,5,7,8,38,39,45,46] included in this analysis (1) used long-acting local anesthetics, (2) used ultrasound guidance for block placement, and (3) did not use long-acting narcotic (*i.e.*, morphine) in the spinal anesthetic solution. Our results were also robust to sensitivity analysis for block approach (anterior quadratus lumborum injection[8]) and type of spinal anesthetic performed (combined spinal epidural[39]). The risk for publication bias was low for this comparison ($P = 0.703$), and the overall GRADE quality of evidence was rated as moderate because of heterogeneity in the pooled estimate.

Secondary Analgesic Outcomes

Area under the Curve for Rest Pain Severity. For all comparisons, the pooled weighted rest pain scores were calculated during recovery room stay (0 to 2 h), and at 4 to 6, 12, 24, and 48 h postoperatively for each group. The analysis for each comparison involved a different number of patients.

For the spinal morphine *versus* spinal morphine and quadratus lumborum block comparison, across the 48-h time interval, the mean difference (99% CI) in area under the curve rest pain scores was −0.4 cm · h (−1.1 to 0.3; $P = 0.186$), suggesting no difference between the groups (Supplemental Digital Content 5, http://links.lww.com/ALN/C509; and Supplemental Digital Content 6, http://links.lww.com/ALN/C510). The P value remained robust to Bonferroni–Holm correction ($P > P_c$). Further, the mean difference did not surpass the cumulative area under the curve for the minimal clinically important difference of 3.96 cm · h across 48 h, suggesting no clinically meaningful difference between the two groups.

For the spinal morphine *versus* quadratus lumborum block comparison, there were insufficient data to include the 48-h time interval; however, across the 24-h time interval, the mean difference (99% CI) in area under the curve rest pain scores was −0.2 cm · h (−0.7 to 0.5; $P = 0.321$), suggesting no difference between the groups (Supplemental Digital Content 5, http://links.lww.com/ALN/C509; and Supplemental Digital Content 6, http://links.lww.com/ALN/C510). The P value remained robust to Bonferroni–Holm correction ($P > P_c$). Further, the mean difference did not surpass the cumulative area under the curve for the minimal clinically important difference of 2.96 cm · h across 24 h, suggesting no clinically meaningful difference between the two groups.

For the no block or spinal morphine *versus* quadratus lumborum block comparison across the 48-h time interval, the mean difference (99% CI) in area under the curve of the pooled rest pain scores favored quadratus lumborum block by −4.4 cm · h (−5.0 to −3.80; $P < 0.00001$; Supplemental Digital Content 5, http://links.lww.com/ALN/C509; and Supplemental Digital Content 6, http://links.lww.com/ALN/C510), and the P value remained robust to Bonferroni–Holm correction ($P < P_c = 0.006$). Further, the mean difference surpassed the cumulative area under the curve for the minimal clinically important difference of 3.96 cm · h across 48 h, suggesting a clinically meaningful improvement to using block *versus* no block.

Rest Pain Severity Scores at Individual Time Points. For spinal morphine *versus* spinal morphine and quadratus lumborum block, the weighted mean difference (99% CI) in rest pain scores during recovery room stay[5,40] and at 12,[6,42] 24,[5,6,40,42] and 48 h[6,42] postoperatively was found to be 0.1 cm (−0.3 to 0.5; $P = 0.657$), 0.0 cm (−0.5 to 0.4; $P = 0.815$), 0.0 cm (−0.9 to 0.8; $P = 0.875$), and 0.1 cm (−0.4 to 0.6; $P = 0.724$), respectively (Supplemental Digital Content 6, http://links.lww.com/ALN/C510). These differences were not statistically significant and remained robust to Bonferroni–Holm correction ($P > P_c$). The GRADE of evidence was rated as high at all time intervals.

For spinal morphine *versus* quadratus lumborum block, the weighted mean difference (99% CI) in rest pain scores during recovery room stay[5,7,40,41] and at 12[7,41] and 24 h[5,7,40,41] postoperatively was found to be 0.1 cm (−0.3 to 0.4; $P = 0.511$) to −1.1 cm (−3.8 to 1.6; $P = 0.289$), and −0.3 cm (−1.8 to 1.3; $P = 0.659$), respectively (Supplemental Digital Content 6, http://links.lww.com/ALN/C510). These differences were not statistically significant and remained robust to Bonferroni–Holm correction ($P > P_c$). There were insufficient data to conduct this analysis for the 48-h time interval. The GRADE of evidence was rated as moderate at all time intervals because of significant heterogeneity in the pooled estimates.

For no block or spinal morphine *versus* quadratus lumborum block, the weighted mean difference (99% CI) in rest pain scores during recovery room stay[4,5,7,8,38,39,46] and at 12,[4,7,8,38,39,45,46] 24,[4,5,7,8,38,39,45,46] and 48 h[4,7,38,39,45,46] postoperatively was found to be −0.8 cm (−1.6 to −0.1; $P = 0.003$), −1.4 cm (−2.9 to 0.0; $P = 0.012$), −0.7 cm (−1.3 to 0.0; $P = 0.009$), and −0.2 cm (−0.5 to 0.0; $P = 0.006$), respectively (Supplemental Digital Content 6, http://links.lww.com/ALN/C510). Quadratus lumborum block appeared to reduce pain during recovery room stay and at 24 and 48 h postoperatively but was no different than no block or spinal morphine at 12 h. The P values remained robust after the Bonferroni–Holm correction for (1) recovery room stay ($P < P_c = 0.007$), (2) 24 h ($P < P_c = 0.010$), and (3) 48 h ($P < P_c = 0.008$). In contrast, although nonsignificance was observed for the 12-h time point (99% CI crossed 0), the Bonferroni–Holm correction revealed statistical

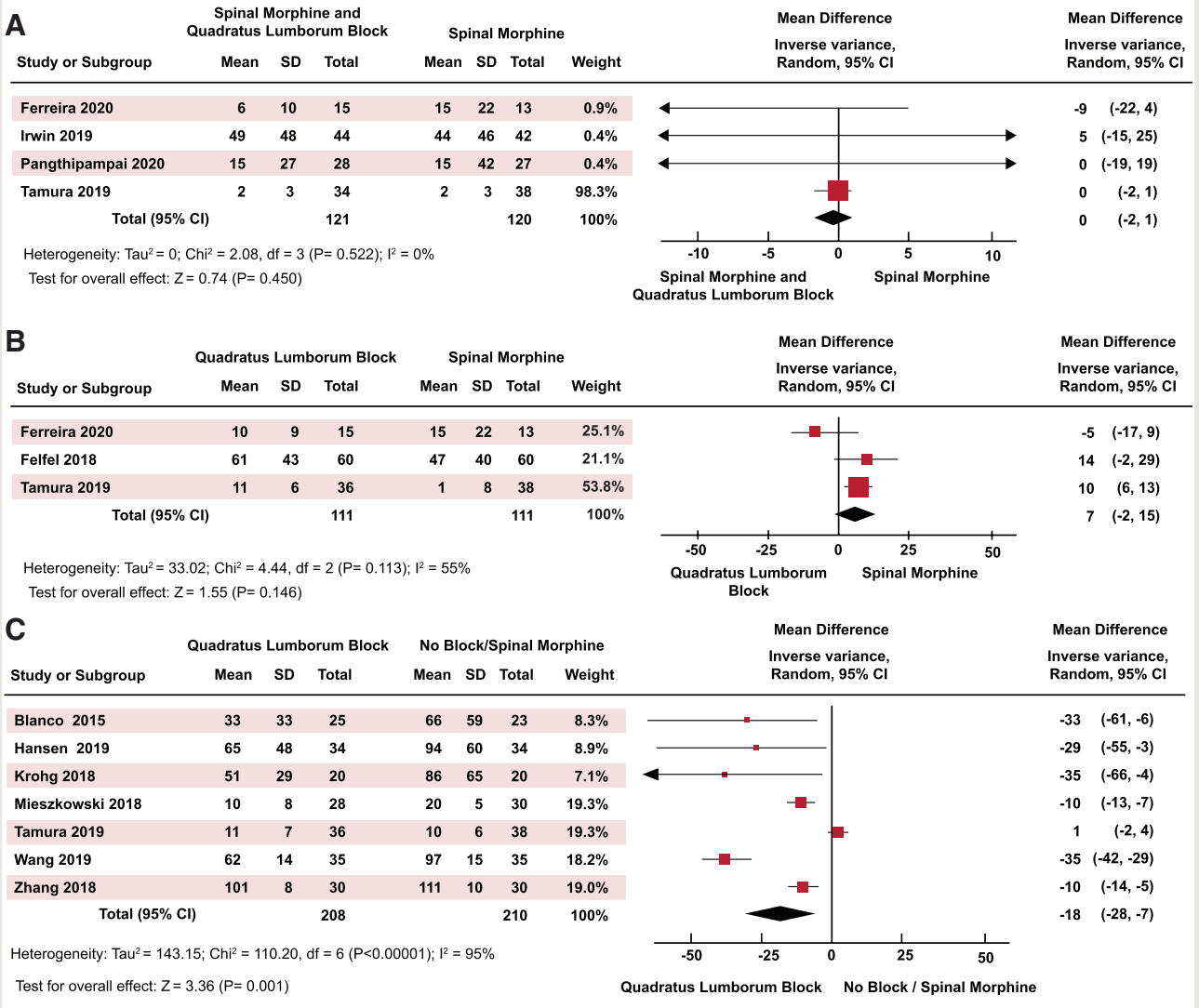

Fig. 1. *Forest plot* of cumulative oral morphine equivalent consumption at 24 h for (*A*) spinal morphine *versus* spinal morphine and quadratus lumborum block, (*B*) spinal morphine *versus* quadratus lumborum block, and (*C*) no block or spinal morphine *versus* quadratus lumborum block. Pooled estimates of the weighted mean difference are shown with 95% CI. Pooled estimates are represented as *diamonds*, and *lines* represent the 95% CI.

significance ($P < P_c = 0.013$). The GRADE of evidence was rated as high at the 48-h time interval but moderate at the remaining time intervals because of significant heterogeneity in the pooled estimates.

Time to Analgesic Request. There were insufficient data to conduct this analysis for the (1) spinal morphine *versus* spinal morphine and quadratus lumborum block and (2) spinal morphine *versus* quadratus lumborum block comparisons.

For no block or spinal morphine *versus* quadratus lumborum block, five studies[4,7,8,38,39] (n = 318: no block or spinal morphine = 159, quadratus lumborum block = 159) provided data that were permissive to statistical pooling. Overall, quadratus lumborum block did not reduce time to first analgesic request as compared with no block or spinal morphine, with a weighted mean difference (99% CI) of 7.5 h (−6.3 to 21.4; $P = 0.166$, $I^2 = 100\%$; Supplemental Digital Content 6, http://links.lww.com/ALN/C510), and the P value remained robust to Bonferroni–Holm correction ($P > P_c = 0.025$). The GRADE of evidence was rated as moderate because of significant heterogeneity in the pooled estimate.

Time to Ambulation. There were insufficient data to conduct this analysis for the spinal morphine *versus* spinal morphine and quadratus lumborum block comparison.

For spinal morphine *versus* quadratus lumborum block, two studies[7,41] (n = 180: spinal morphine = 90, quadratus lumborum block = 90) provided data that were permissive

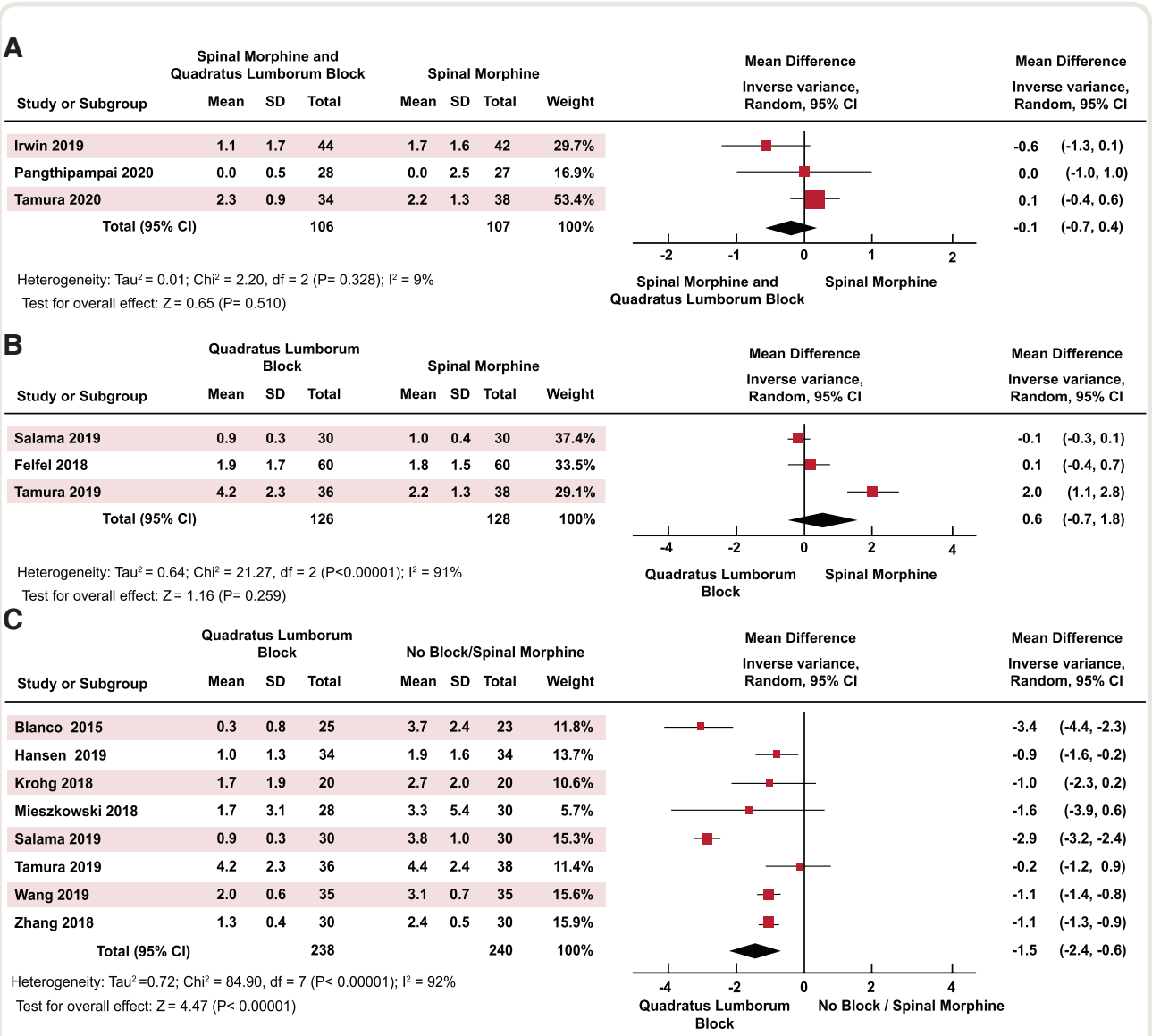

Fig. 2. *Forest plot* of rest pain scores at 4 to 6 h postoperatively for (*A*) spinal morphine *versus* spinal morphine and quadratus lumborum block, (*B*) spinal morphine *versus* quadratus lumborum block, and (*C*) no block or spinal morphine *versus* quadratus lumborum block. Pooled estimates of the weighted mean difference are shown with 95% CI. Pooled estimates are represented as *diamonds*, and *lines* represent the 95% CI.

to statistical pooling. Overall, quadratus lumborum block did not reduce time to ambulation as compared with spinal morphine, with a weighted mean difference (99% CI) of 1.4 h (−1.2 to 4.0; $P = 0.161$, $I^2 = 80\%$; Supplemental Digital Content 6, http://links.lww.com/ALN/C510), and the P value remained robust to Bonferroni–Holm correction ($P > P_c = 0.006$). The GRADE of evidence was rated as moderate because of significant heterogeneity in the pooled estimates.

For no block or spinal morphine *versus* quadratus lumborum block, three studies[7,8,46] (n = 168: no block or spinal morphine = 84, quadratus lumborum block = 84) provided data that were permissive to statistical pooling. Overall, quadratus lumborum block did not reduce time to ambulation as compared with no block or spinal morphine, with a weighted mean difference (99% CI) of 1.3 h (−0.1 to 2.6; $P = 0.017$, $I^2 = 64\%$; Supplemental Digital Content 6, http://links.lww.com/ALN/C510), and the P value remained robust to Bonferroni–Holm correction ($P > P_c = 0.016$). The GRADE of evidence was rated as moderate because of significant heterogeneity in the pooled estimate.

Patient Satisfaction. For spinal morphine *versus* quadratus lumborum block, three studies[7,40,41] (n = 208: spinal morphine = 103, quadratus lumborum block = 105) provided

data that were permissive to statistical pooling. Overall, quadratus lumborum block was no different than spinal morphine for patient satisfaction, with a weighted mean difference (99% CI) of 2.2 cm (−3.8 to 8.1; $P = 0.346$, $I^2 = 100\%$; Supplemental Digital Content 6, http://links.lww.com/ALN/C510), and the P value remained robust to Bonferroni–Holm correction ($P > P_c = 0.007$). The GRADE of evidence was rated as moderate because of significant heterogeneity in the pooled estimates.

There were insufficient data to conduct this analysis for the (1) spinal morphine *versus* spinal morphine and quadratus lumborum block and (2) no block or spinal morphine *versus* quadratus lumborum block comparisons.

Opioid-related Side Effects

For spinal morphine *versus* spinal morphine and quadratus lumborum block, four studies[5,6,40,42] (n = 241: spinal morphine = 120, spinal morphine and quadratus lumborum block = 121) provided data that were permissive to statistical pooling. Overall, spinal morphine and quadratus lumborum block were not different from spinal morphine for this outcome ($P = 0.359$; Supplemental Digital Content 6, http://links.lww.com/ALN/C510), and the P value remained robust to Bonferroni–Holm correction ($P > P_c = 0.010$). The GRADE of evidence was rated as high.

For spinal morphine *versus* quadratus lumborum block, four studies[5,7,40,41] (n = 282: spinal morphine = 141, quadratus lumborum block = 141) provided data that were permissive to statistical pooling. Overall, quadratus lumborum block reduced the odds of opioid-related side effects by 0.5 times (95% CI, 0.2 to 0.9; $P = 0.005$, $I^2 = 0\%$; Supplemental Digital Content 6, http://links.lww.com/ALN/C510), and the P value remained robust to Bonferroni–Holm correction ($P < P_c = 0.006$). The GRADE of evidence was rated as high.

For no block or spinal morphine *versus* quadratus lumborum block,[4,5,7,8,39,45,46] seven studies (n = 406: no block or spinal morphine = 205, quadratus lumborum block = 201) provided data that were permissive to statistical pooling. Overall, quadratus lumborum block was not different from no block or spinal morphine for this outcome ($P = 0.289$; Supplemental Digital Content 6, http://links.lww.com/ALN/C510), and the P value remained robust to Bonferroni–Holm correction ($P > P_c = 0.050$). The GRADE of evidence was rated as high.

Block-related Complications. Across all studies included in this analysis,[4–6,42,46] no block-related complications (*i.e.*, hematoma, organ injury, local anesthetic systemic toxicity, and block failure) were reported (Supplemental Digital Content 6, http://links.lww.com/ALN/C510). The GRADE of evidence was rated as low because of limited studies included in the analysis.

Outcomes with Insufficient Reporting

None of the included trials assessed requirement for breakthrough analgesia in recovery room, time to voiding, time to breastfeeding, and block performance time.

Discussion

Our systematic review and meta-analysis elucidates the potential role of quadratus lumborum block in providing postoperative analgesia after elective cesarean delivery under spinal anesthesia. Specifically, the quadratus lumborum block appears to have no analgesic benefit for patients already receiving spinal morphine, as demonstrated by similar rest pain scores and analgesic consumption during the first 24 h postoperatively. There also appears to be no benefit when spinal morphine is compared with quadratus lumborum block as an analgesic alternative. However, evidence suggests benefit when quadratus lumborum block is administered with spinal anesthesia in the absence of spinal morphine. This was demonstrated by improved acute rest pain control at 4 to 6 h and analgesic consumption during the first 24 h postoperatively, as well as a clinically important improvement in overall rest pain over the 48-h interval. Finally, no differences between no block or spinal morphine and quadratus lumborum block were found for all other analgesic and safety outcomes (opioid-related side effects and block-related complications). Taken together, these findings do not support administering a quadratus lumborum block when spinal morphine is used because no additional analgesic benefit is realized. However, the block could be considered for postcesarean analgesia patients who receive spinal anesthesia without spinal morphine.

Inadequately controlled pain after cesarean delivery can be detrimental to early mobilization and adequate newborn care.[47] In the era of enhanced recovery after surgery,[47] postcesarean delivery pain management is largely multimodal and incorporates acetaminophen, nonsteroidal anti-inflammatory medications, long-acting intrathecal opioids (*i.e.*, spinal morphine) and, occasionally, weak opioids.[48–50] Spinal morphine, specifically, plays a major role in the multimodal analgesic regimen, as per contemporary guidelines[1,51]; our findings herein further highlight its integral role[52] as well as its superiority over proposed alternatives for elective cesarean delivery. However, in the absence of spinal morphine, postcesarean delivery pain management may be challenging. In that specific scenario, there appears to be a definitive analgesic advantage for adding a quadratus lumborum block, which may suggest a potential role in patients with an inadequate spinal anesthetic or who cannot receive spinal morphine because it is not feasible or should be avoided.[53]

Several other abdominal wall blocks have also been proposed for cesarean delivery, including the transverse abdominis plane blocks,[54] erector spinae plane block,[55,56] and the iliohypogastric and ilioinguinal nerve blocks.[57,58] However, multimodal analgesia inclusive of spinal

morphine is a strong analgesic that may mitigate the need for any additional interventions. Indeed, this has been previously demonstrated for transversus abdominis plane block, which, when used as a part of a multimodal regimen inclusive of spinal morphine, does not add any analgesic benefits.[54] This earlier finding is curiously analogous to our conclusions herein and seems to limit the potential clinical role of quadratus lumborum block. That said, the quadratus lumborum block is not a benign intervention and has been found to be associated with several complications including hematoma and organ injury,[19] and although no block-related complications were reported by this review, our analysis is clearly underpowered to determine their true incidence. Additionally, block placement requires additional time, effort (lateral position needed for anterior and posterior quadratus lumborum blocks), and skill, something that may not be practical for certain centers.

Strengths and Limitations

Our systematic review and meta-analysis has several strengths. First, our review comprehensively synthesized evidence on all clinical scenarios for use of quadratus lumborum block for postcesarean delivery analgesia. Second, through our comprehensive search strategy, we were able to successfully include non-English studies and completed/ongoing trials registered on http://www.clinicaltrials.gov. Third, through contact with the corresponding authors of all included studies, we were able to obtain additional data that were included in our analyses. Fourth, our review successfully pooled and performed metaregression analysis across a variety of clinically important outcomes for all prespecified comparisons. Finally, our calculated *P* values for all secondary outcomes were robust to the Bonferroni–Holm correction.

Our review also has limitations that are worth noting. First, both our primary and secondary outcome analyses were characterized by high levels of heterogeneity, which were not fully explained in our metaregression analysis. The residual unexplained heterogeneity may be attributed to variability in the doses of short-acting spinal opioids, doses of spinal local anesthetics, and postoperative multimodal analgesic regimens used. Second, many of the included studies had small sample sizes, placing them at risk of overestimation of treatment effect.[59] For instance, conclusions relating to comparisons in the setting of spinal morphine and comparison with spinal morphine were based on data from three to four studies, warranting additional confirmatory investigation. Additionally, the treatment effect of the comparison performed in the setting of spinal morphine appears to be driven by the results of one trial,[5] but *post hoc* sensitivity analysis by exclusion of this trial did not alter the results. Third, many of the included trials also had a medium-high risk of bias because of difficulties in blinding block techniques. Fourth, inconsistent reporting across the included studies for clinically important outcomes such as time to voiding and time to breastfeeding could not be evaluated because of limited reporting. Fifth, although our review did not identify any block-related complications, the pooled sample size is unlikely to provide sufficient power to evaluate this uncommon outcome, rendering the quality of evidence low. Sixth, postcesarean delivery visceral pain is reported in more than 50% of patients,[60] and they may theoretically benefit from the purported spread into the thoracic paravertebral space.[61,62] However, we were unable to ascertain this benefit because trials did not specifically evaluate visceral pain. Seventh, variations in type and dose of short-acting spinal opioid (*i.e.*, fentanyl and sufentanil) may have had a confounding effect, but our metaregression analysis did not detect any associations. Eighth, even though we adjusted the *P* value for our secondary outcome analyses ($P < 0.01$), we may not have completely eliminated the risk of type 1 error because of the large number of secondary outcomes analyzed. Ninth, we were unable to comment on block performance time, but the block clearly has implications on operating room time and costs. Finally, examining analgesic outcomes *per se* may not be the best approach to quantify the benefits of truncal blocks in the setting of cesarean delivery, owing to the overwhelming efficacy of spinal morphine. Future studies addressing similar questions may want to consider different outcomes, such as functional outcomes and quality of recovery.

Conclusions

In summary, moderate-quality evidence suggests that the quadratus lumborum block does not appear to provide any added analgesic benefit for patients in the postoperative period when spinal morphine is administered. However, the block appears to be effective for postcesarean analgesia in patients who receive spinal anesthesia without spinal morphine. In these patients, the analgesic benefits include a reduction in oral morphine equivalent consumption at 24 h and a clinically meaningful improvement in rest pain throughout the 48-h postoperative period.

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Support for this study was provided solely from institutional and/or departmental sources.

Competing Interests

Dr. Essandoh receives consultancy fees from Boston Scientific (Marlborough, Massachusetts) and S4 Medical (Ohio). The remaining authors declare no competing interests.

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