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SYSTEMATIC REVIEW

# Erector spinae plane block for analgesia after cesarean delivery: a systematic review with meta-analysis

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**Abstract**
*Background:* Erector spinae plane block (ESPB) is a regional block that may be used for several surgeries. However, the evidence regarding obstetrical procedures is not pooled in the literature.
*Objectives:* To assess whether ESPB improves the postoperative pain after cesarean section by a systematic review and meta-analysis.
*Methods:* The protocol of this review was registered on PROSPERO (CRD42020192760). We included randomized controlled trials from databases until August 2020. The primary outcome was pain measured on a visual analogic scale; secondary outcomes were analgesic duration, postoperative opioid dose within the 24 hours, nausea/vomiting. The risk of bias and the GRADE criteria to assess quality of evidence were analyzed.
*Results:* From 436 retrieved studies, three were selected. There was no difference in the pain scores between ESPB and controls at rest after surgery at 4 h (mean difference [MD] = 0.00; 95% CI: -0.72 to 0.72; $I^2$ = 0%; very low certainty), 12 h (MD = -1.00; 95% CI: -2.00 to -0.00; $I^2$ = 0%, low certainty) and 24 h (MD = -0.68; 95% CI: -1.56 to 0.20; $I^2$ = 50%; very low certainty). There was a smaller consumption of tramadol with ESPB compared with controls (MD = -47.66; 95% CI: -77.24 to -18.08; $I^2$ = 59%; very low certainty). The analgesic duration of ESPB was longer than the controls (MD = 6.97; 95% CI: 6.30 to 7.65; $I^2$ = 58%; very low certainty).
*Conclusion:* ESPB did not decrease the postoperative pain scores when compared to other comparators. However, ESPB showed a lower consumption of tramadol and a longer blockade duration, although the quality of evidence of these outcomes were very low.


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## Introduction

Cesarean section corresponds to 18% of all reported deliveries worldwide and it provides high postoperative pain scores, delaying early mobilization and the mother's independence in the care of her newborn.[1,2] Within non-obstetric surgeries, peripheral nerve blockade is used as part of a multimodal analgesic strategy that provides effectiveness in patient recovery, reduces hospital expenses and the need for using opioids.[3] This strategy for obstetrical procedures is still scarcely known with regard to its utility and effectiveness.

Recently, erector spinae plane block (ESPB) was described in 2016 by Forero et al. for treating neuropathic pain.[4,5] It is a paraspinal fascial plane block guided by ultrasound consisting of an injection of local anesthetic deep into the erector spinae muscle and also superficial to the transverse processes.[6] It aims to provide analgesia on both sides for several dermatomes at the level of injection and may be potentially effective to block somatic and visceral pain.[7] Since its implementation, ESPB has been assessed in several surgical procedures such as cholecystectomy, inguinal herniorrhaphy, hip and breast surgeries, and abdominal hysterectomies.[4,8–13] There are narrative reviews regarding its use but to this moment, there is not a systematic review summarizing the quantitative data and assessing the quality of evidence of its use on cesarean delivery.[14,15] Therefore, we sought to assess the role of ESPB for analgesia after cesarean delivery by a systematic review and meta-analysis.

## Methods

### Study selection and eligibility criteria

The authors followed the guideline PRISMA[16] to perform this systematic review; it was prospectively registered on the PROSPERO (CRD42020192760) database.[17] Institutional Review Board exempted this work from analysis because it was a systematic review. The research question was designed according to the strategy design PICOS[18] (Population, Intervention, Comparator, Outcome Study): does the erector spinae plane block improve postoperative pain in women undergoing cesarean section compared to another analgesic technique?

The Cochrane Library, Embase, PubMed, and Web of Science databases were scrutinized to find pertinent literature from their inception until August 2020, without language restrictions. The search terms used were: ( ( ( ëretorÖR ërector¨) AND ( s̈pinaeÖR s̈pinal¨) OR ës̈p¨) AND ( c̈esarean sectionÖR C̈-sectionÖR c̈aesarean section¨) ). MeSH terms were also applied for the terms displayed above (eg., cesarean section (MeSH heading and subheadings). A broad search strategy was considered because the authors hypothesized that few studies would be available. Inclusion criteria were: (1) prospective studies and randomized controlled trials; (2) women that underwent a cesarean section; (3) trials that comprehended two intervention groups: the experimental arm would be the ESPB group and the other, with sham control or other comparators. The investigators also checked references and related articles for each database. Retrospective studies, conference abstracts, reviews, or editorials were not assessed in this review. Two reviewers (IDVRJ, LGOB) separately screened the titles and abstracts of all retrieved articles. Duplicate articles were removed. Abstracts that met the inclusion criteria were screened for further analysis. Full-text articles were afterward judged by the two reviewers, and in the event of disagreement it was resolved by a third co-author (VHC) for consensus.

### Outcomes

The primary outcome was pain at rest and at movement, measured by visual analogic scale (VAS), continuous variable (range 0–10). Movement was defined by coughing, moving the lower limbs, sitting, and walking. Secondary outcomes were time to first analgesic request by the patient, continuous variable, regardless of quantification of pain in two of the three studies and VAS $\geq$ 4 in another, in hours; total opioid dosage requested by patient, in milligrams, continuous variable, within 24 hours after surgery; nausea and vomiting.[19–21]

### Data extraction

Study characteristics such as sample size, inclusion and exclusion criteria, primary and secondary outcomes, randomization, and allocation processes were extracted using an electronic, pilot-tested data form by two reviewers independently. When variables described in both trials were reported in a different format or any missing variable, we emailed the authors to obtain data and reduce reporting bias but there was no return.

### Quality assessment

Cochrane's risk of bias (Cochrane Handbook for Systematic Reviews of Intervention – version 6.0)[22] and the GRADE (Grading of Recommendations, Assessment, Development and Evaluation)[23] criteria were independently revised by the two reviewers independently to assess the randomized clinical trials. For risk of bias, the studies were classified as ''low risk'', ''unclear risk'', and ''high risk'' for the following categories: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, selective reporting, and other biases. The GRADE system was used to rate the quality of evidence and to grade the strength of the recommendations of the studies retrieved for quality analysis. Discrepancy about classification or quality were resolved by consensus in discussion with the third author.

### Statistical analysis

A meta-analysis was performed for each variable represented in at least two studies. Risk of bias and data analysis was performed using RevMan version 5.4. (Cochrane Collaboration, Copenhagen, Denmark).[24] Heterogeneity was calculated with the $I^2$ test and if percentage was greater than 50%, a random-effect analysis was carried out. Odds ratio (OR) plus lower and higher interval values for dichoto-

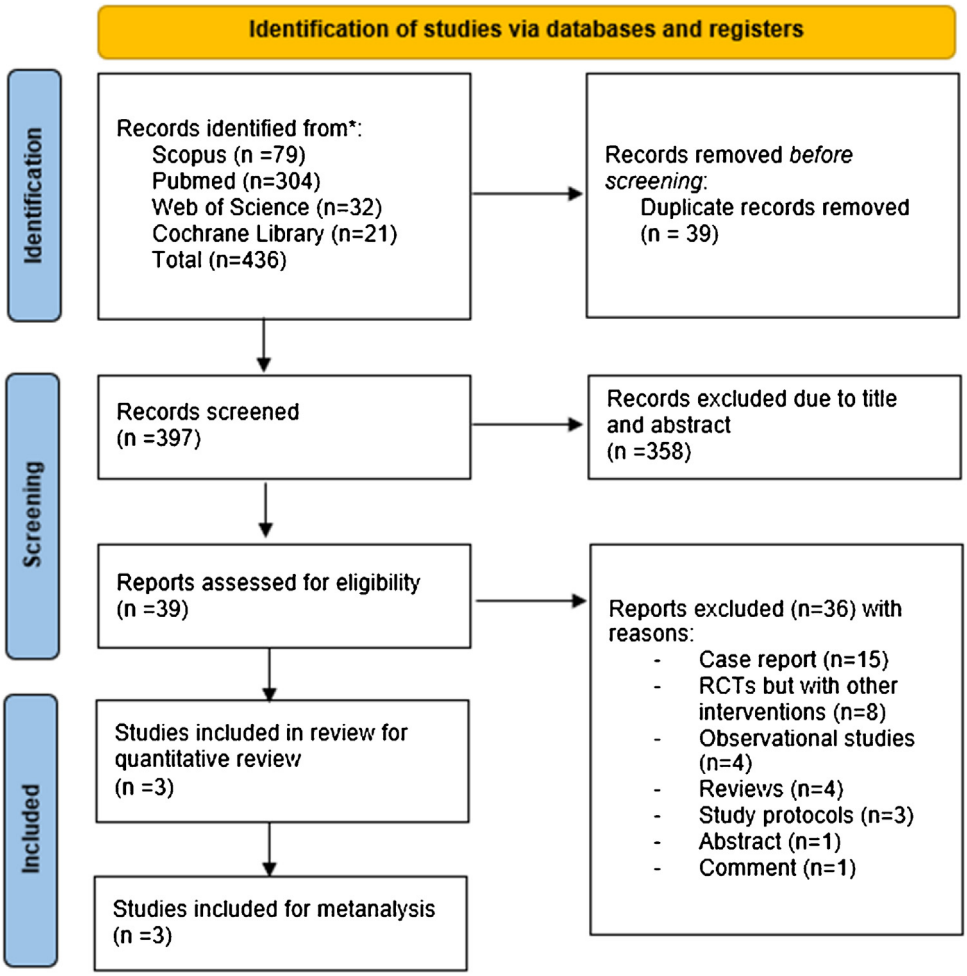


**Figure 1** PRISMA Flowchart of the depicted studies.

mous variables or mean difference (MD) plus 95% confidence intervals for continuous variables were calculated. According to the Cochrane Handbook, if the distribution was normal for variables that were expressed in medians, we transformed it into means using the following mathematical calculation: the median could be approximated for the mean and the width of the interquartile range would be approximately 1.35 times the standard deviation. Due to the small number of retrieved studies, no funnel plot or subgroup analysis was performed.[22]

## Results

A total of 436 results were retrieved from the databases. Figure 1 depicts all the pathways for selecting the studies. After exclusion of duplicates and screening, we selected three articles for full-text assessment which remained for quantitative analysis and meta-analysis, comprising 260 women.[19–21]

The main characteristics of the included studies are shown in Table 1. All women were submitted to cesarean section under intrathecal anesthesia with bupivacaine whose dose varied between 10 to 12.5 mg. The local anesthetic was injected guided by ultrasound into the erector spinae plane in all RCTs, at the level of the ninth thoracic vertebra. Two studies[19,21] compared the ESPB with TAP block, whereas the third was compared with intrathecal morphine associated with sham block.[20] Bupivacaine (100 mg and 200 mg) was employed in two works,[19,20] whereas the third study used ropivacaine 0.2% (0.4 mL.kg$^{-1}$).[21]

Two studies have administered intravenous ketorolac and acetaminophen, as well tramadol by patient-controlled analgesia (PCA).[19,20] The third study administered intravenous diclofenac.[21] Time to first request was the primary outcome in two studies.[19–21]

### Risk-of-bias and quality of the evidence

Figure 2 depicts the risk of bias summary. Boules et al. have shown a high risk for blinding participants.[19] Malawat et al. presented two high risks (incomplete outcome data – sample size calculation needed 53 patients, but only 30 were recruited; selective reporting bias – no description of standard deviation for blockade duration).[21] There was only one unclear risk about the blinding of participants.[20] About the GRADE criteria, risk of bias was serious for almost all variables, except the pain movement at 12 h (very serious). All outcomes were rated very serious for indirectness and due

**Table 1** Characteristics of published trials.

| | Maternal age (mean ± SD) | Weight (kg) | Surgical duration (min) | Sample size (interven-tion/ comparator) | ESPB (volume each side) | Comparator/ Drug (volume each side) | Anesthetic | Postoperative analgesia | Primary/ Secondary outcomes |
|---|---|---|---|---|---|---|---|---|---|
| Boules 2020 | ESPB (27.1 ± 6)<br>TA P (28.9 ± 5.5) | ESPB (91.9 ± 8.4)<br>TAP (89.5 ± 11.6) | Not informed | 30/30 | Bupivacaine 0,25%<br>(20 mL) | TAP bupivacaine 0,25% (20 mL) | Hyperbaric bupiva-caine<br>10-12 mg IT | Ketorolac 30 mg IV 12/12h<br>Paracetamol 1 g IV 8/8h<br>Tramadol IV PCA | Primary<br>Duration of analgesia<br>Secondary<br>VAS pain at rest and after cough at 0,4,8,12 and 24hrs<br>Total tramadol consumption<br>Satisfaction<br>Adverse effects or complications |
| Hamed 2020 | ESPB (27.97 ± 6.03)<br>ITM (27.57 ± 6.11) | Not informed | ESP (39.69 ± 11.81)<br>ITM (39.83 ± 11.97) | 70/70 | Bupivacaine 0,50%<br>(20 mL) | Morphine 100 mcg | Hyperbaric bupiva-caine<br>10 mg IT | Ketorolac 30 mg IV at block<br>Paracetamol 1 g IV 8/8h<br>Tramadol IV PCA | Primary<br>VAS pain at rest at 8h<br>Secondary |

Table 1 (*Continued*)

| | Maternal age (mean ± SD) | Weight (kg) | Surgical duration (min) | Sample size (intervention/ comparator) | ESPB (volume each side) | Comparator/ Drug (volume each side) | Anesthetic | Postoperative analgesia | Primary/ Secondary outcomes |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Total tramadol consumption<br>VAS pain on PACU, 4, 12, 16 and 24 hrs<br>First analgesic request<br>Satisfaction<br>Side Effects or complication |
| Malawat 2020 | ESP (28 ± 3) | ESP (69 ± 5) | ESP (45 ± 10) | 30/30 | Ropivacaine 0,2% | TAP | Hyperbaric bupivacaine | Diclofenac 75 mg IV | Primary |
| | TA P (30 ± 3) | TAP (70 ± 4) | TAP (44 ± 9) | | 0.2 mL.kg-1 | Ropivacaine 0,2% 0.2 mL.kg-1 | 12.5 mg IT | | First analgesic request<br><br>Secondary<br>Total dose of analgesic in the first 48h<br>VAS at rest and on the movement at 2, 4, 6, 12, 24, 36, 48 hrs) |

ESPB, erector spinal plane block; TAP, transversus abdominis block; IT, intrathecal; PCA, patiente-controlled analgesia; IV, intravenous; VAS, Visual Analogue Pain; PACU, post-anesthesia care unit.

**Table 2** GRADE evidence: erector spinae plane block vs others controls.

| | n. of women | Risk of bias | Inconsistency | Indirectness | Imprecision | Publication bias | Quality |
|---|---|---|---|---|---|---|---|
| Pain rest 4h | 200 | Serious[a] | Not serious | Very serious[d,e] | Serious[f] | Undetected | Very low |
| Pain rest 12h | 200 | Serious[a] | Not serious | Very serious[d,e] | Serious[f] | Undetected | Very low |
| Pain rest 24h | 200 | Serious[a] | Serious[c] | Very serious[d,e] | Serious[f] | Undetected | Very low |
| Pain movement 4h | 200 | Serious[a] | Serious[c] | Very serious[d,e] | Serious[f] | Undetected | Very low |
| Pain movement 12h | 260 | Very serious[a,b] | Not serious | Very serious[d,e] | Serious[f] | Undetected | Very low |
| Pain movement 24h | 200 | Serious[a] | Not serious | Very serious[d,e] | Serious[f] | Undetected | Very low |
| Consumption of tramadol | 200 | Serious[a] | Serious[c] | Very serious[d,e] | Very serious[f,g] | Undetected | Very low |
| Duration of block | 200 | Serious[a] | Serious[c] | Very serious[d,e] | Serious[f] | Undetected | Very low |

[a] Due to blinding.
[b] One study needed 53 participants at each group, but it included 30 (Malawat et al. 2020).
[c] High heterogeneity (50-60% by $i^2$ test).
[d] Different drugs and dosages in the intervention group.
[e] Different comparators.
[f] Sample size lesser than 400.
[g] Confidence Interval limits from one study are too wide.

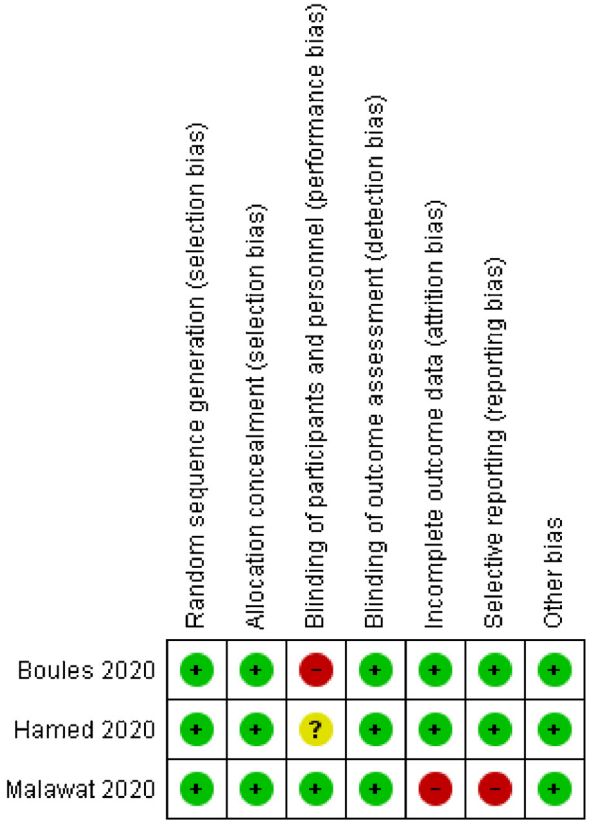


**Figure 2** Risk of bias summary.

to different comparators and drugs. Quality of the evidence was rated very low in all eight graded variables (Table 2). No publication bias was noted in the analysis.

## Postoperative pain scores at rest and during movement

Pain (Fig. 3) was assessed by three studies and there was no statistical difference at the following time frames: at rest at 4 h (MD = 0.00; 95% CI: -0.72 to 0.72; $I^2$ = 0%), 12 h (-1.00; 95% CI: -2.00 to -0.00; $I^2$ = 0%), and 24 h (-0.68; 95% CI: -1.56 to 0.20; $I^2$ = 50%) after surgery; and at movement at 4 h (-0.68; 95% CI: -1.56 to 0.20; $I^2$ = 50%), 12 h (-1.00; 95% CI: -2.07 to 0.07; $I^2$ = 0%), and after 24 h (0.00; 95% CI: -1.12 to 1.12; $I^2$ = 0%) post-surgery. Most of the variables presented low heterogeneity.

## Time to first request and tramadol consumption

Time to first request (Fig. 4) was the primary outcome in two studies ranging from 12 up to 43 hours[19,21] while morphine intrathecal lasted almost five hours.[20] The TAP block had duration between eight and 12 hours.[19,21] The longer duration of ESPB compared to the control was significant (6.13; 95% CI: 3.36 to 8.90; $I^2$ = 58%). Two studies showed a smaller consumption of tramadol measured by PCA with ESPB compared with controls (MD: -47.66; 95% CI: -77.24 to -18.08; $I^2$ = 59%).[19,20]

No statistically significant difference was found between the ESPB and controls at two studies that evaluated women's satisfaction.[19,20] Two RCTs didn't show any side effects or complications,[19,20] while Malawat et al. didn't appraise these two outcomes.[21]

## Discussion

Our systematic review with meta-analysis found that the ESPB did not decrease the postoperative pain scores when compared to other comparators. However, ESPB showed a lower consumption of tramadol and a longer blockade duration, although the quality of evidence of these outcomes was rated very low scores. It is important to point out that two of the three selected studies were from the same authors and sample sizes were similar between the studies, influencing the pooled data and possibly to a lack of difference between the groups.

In a recent meta-analysis published about ESPB for adults undergoing abdominal, chest, or spinal surgeries, a lower pain score occurred in the first 24 hours after surgery in the ESPB group (mean reduction between 1.2 and 2.27) when it has been compared to sham group (or no block); the authors

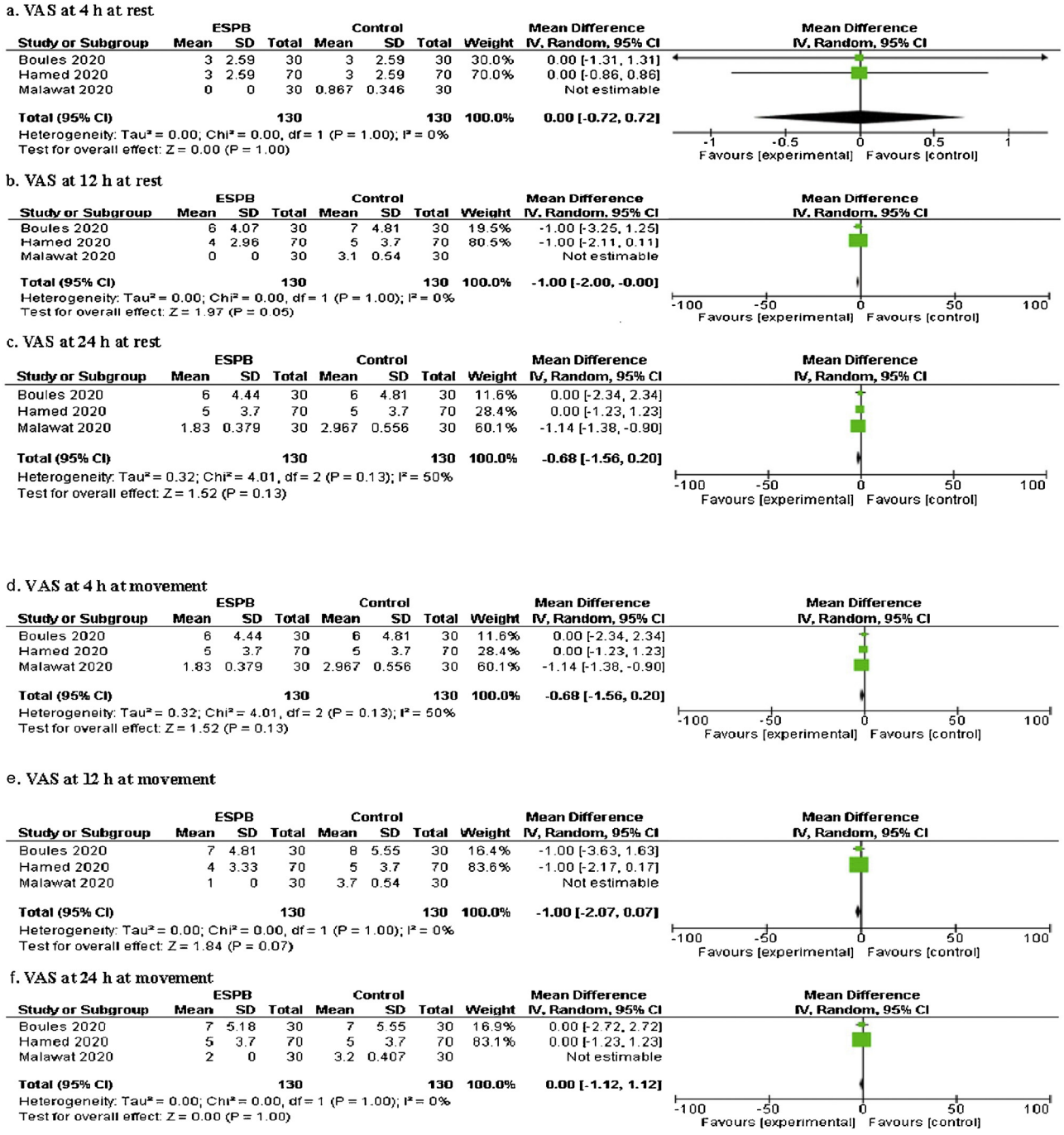


**Figure 3** VAS at rest (a) 4 hours after surgery; (b) 12 hours after surgery; (c) 24 hours after surgery. VAS during movement (d) 4 hours after surgery; (e) 12 hours after surgery; (f) 24 hours after surgery.
VAS at rest – a: 4 hours after surgery; b: 12 hours after surgery; c: 24 hours after surgery.
VAS during movement; d: 4 hours after surgery; e: 12 hours after surgery; f: 24 hours after surgery.

wondered whether those results had clinical significance as it promotes minimum impact on the referred pain[25] just as our results did not detect any improvement in postoperative pain. This can be explained due to the fact that all patients in the three RCTs had the spinal block as the primary anesthesia, both intervention and control groups, with the neuraxial block providing somehow a protective factor for pain.

Another meta-analysis evaluating the ESPB for postoperative analgesia during breast and/or thoracic surgery also noticed that the ESPB exhibited lower pain score when compared with no block or sham block perhaps because the surgeries were conducted under general anesthesia, which would not provide the protective factor mentioned earlier in the spinal block; however, when it was compared to paravertebral block, the scores were not different between the

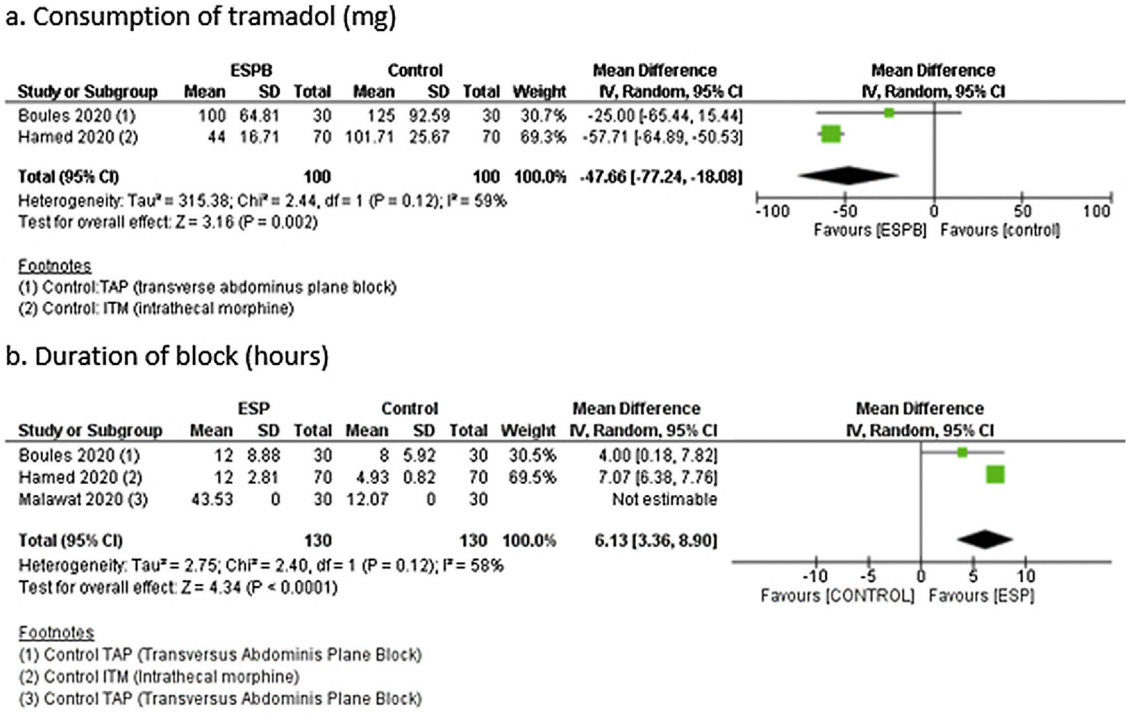


**Figure 4** Consumption of tramadol (a) and blockade duration (b).
Footnotes:
(1) Control TAP (Transversus Abdominis Plane Block)
(2) Control ITM (Intrathecal morphine)
(3) Control TAP (Transversus Abdominis Plane Block)

groups.[14] Future studies addressing this subject would help to explain whether this difference exists or not.

Two meta-analyses have observed a lower consumption of morphine although with high heterogeneity even when subgroup analysis was performed.[14,25] Our study reported a lower consumption of tramadol; however, one interesting point is that the incidence of postoperative nausea and vomiting has not been reduced despite the lower requirement for opioids. Unlike previous studies that investigated the ESPB combined to general anesthesia, ESP block performed at cesarean surgery in combination with spinal anesthesia seems to follow a different pathway probably because the women received neuraxial anesthesia which has a protective effect at postoperative pain, nausea and vomiting.[26,27] The duration of the ESPB of two studies was approximately twelve hours,[19,20] more than the controls: TAP block performed eight hours and intrathecal morphine was approximately five hours. Krishna et al reported ten hours after cardiac surgery and Ghamry et al six hours, both at thoracic level.[28,29] Few studies report the time to first analgesic request and consequently, clinical duration of block although this variable can be used as a safer indirect assessment quantifying pain according to Moore et al.[14,30,31]

Our review verified no difference at the incidence of nausea and vomiting; conversely, Cai et al observed a reduction in the incidence of these symptoms.[25] Perhaps reducing the use of opioids was not enough to reduce these complications. Huang et al had a decrease in PONV but only when the ESPB was compared to the non-block group because once compared to other blocks, found no significance as well Huang and Liu.[14,15] With regard to patient satisfaction, there was also no difference between the groups, probably because the results did not show any reduction in postoperative pain or complications that could induce changes in the patients' responses. Moreover, although it has not had records in the literature of local anesthetic toxicity with the use of ESPB, there are reports of priapism, unexpected motor weakness, two cases of pneumothorax, and probably more complications can be described according to the ESPB as most frequently performed.[32–35]

Several factors decreased the quality of evidence in this review such as study limitations, inconsistency of results, several types of comparators, as well types of local anesthetic and blinding of participants.

In this meta-analysis, the erector spinae plane block seems to decrease the consumption of opioids, showing an analgesic effect despite not reducing pain or any side effects.

As strengths, this review was the first to systematically assess the ESPB for postoperative analgesia after cesarean delivery. Furthermore, several important limitations should be considered when interpreting the results. In the first place, only three trials were included, and we hope that with more published works we can corroborate or not some of the findings. Second, all RCTs have a small sample size, consequently it is necessary to increase the sample size to provide more robust evidence, for example, by a subgroup analysis of the interventions and/or control treatments. Third, the number of studies were small to get a conclusion with regard

to the difference of the treatments. Fourth, there are still few studies addressing the ESPB as a field of regional anesthesia to be explored and explained. Fifth, the number of studies in the literature is too limited to conclude on the difference between the treatments, in terms of whether they really provide a considerable reduction in pain and consequently in patient recovery. In addition, the dose and volume of local anesthetics as well as the use of adjuvants is very incipient regarding this block; also, most of the studies were from a specific research group.

Future studies are needed to assess effectiveness of ESPB to provide analgesia and whether it is comparable to other truncal blocks along with neuraxial anesthesia in obstetrical procedures, especially with a higher sample size and correcting methodological aspects of the study design, such as blinding, attrition, and reporting biases.

## Conflicts of interest

The authors declare no conflicts of interest.

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