Systematic Review and Meta-Analysis

Investigation into the clinical performance of rectus sheath block in reducing postoperative pain following surgical intervention: A systematic review and meta-analysis of randomised controlled trials

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ABSTRACT

Background and Aims: Rectus sheath block (RSB) is an effective postoperative pain control technique in abdominal surgical procedures. This systematic review evaluated the efficacy and outcome data of patients undergoing RSB compared to the standard of care in both laparoscopic and open surgical procedures. **Methods:** This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines (PROSPERO ID: CRD42022372596). The search was restricted to randomised controlled trials (RCTs) comparing RSB effectiveness on postoperative pain to any standard general anaesthesia technique (control). We systematically explored PubMed, Medline, Central, Scopus and Web of Science for RCTs from inception to September 2023. The primary outcome was the evaluation of pain scores at rest 0-2, 10-12 and 12-24 h postoperatively. The secondary outcome was the analysis of postoperative intravenous (IV) morphine equivalent consumption at 24-h. A risk-of-bias tool for randomised trials (ROB 2.0, Cochrane, Copenhagen, Denmark) assessment and Grades of Recommendation, Assessment, Development and Evaluation (GRADE, Cochrane, Copenhagen, Denmark) analysis was conducted to evaluate the quality of the RCTs. **Results:** Twenty RCTs involving 708 participants who received RSB intervention and 713 who received alternative analgesic care were included. RSB pain scores were significantly lower than control at 0-2 h ($P < 0.001$) and 10-12 h ($P < 0.001$) postoperatively. No significant effect was observed at 24 h ($P = 0.11$). RSB performance compared to control in 24-h IV morphine equivalency in milligrams was significantly lower ($P < 0.001$). **Conclusion:** RSB implementation was associated with reduced postoperative pain scores and decreased opioid consumption in IV morphine equivalency up to 24 h following surgical intervention.

Key words: Abdominal surgery, postoperative pain, rectus sheath block, regional anaesthesia, systematic review

INTRODUCTION

The rectus sheath block (RSB) was initially described and utilised in 1899 to relax the abdominal muscles during laparotomy before the adjunct of neuromuscular blocks.[1] It involves the administration of local anaesthetic through the rectus abdominis muscle onto the posterior wall of the rectus sheath, effectively blocking the seventh to twelfth terminal branches of the intercostal thoracic nerves.[2] More often, the modern version of the technique utilises ultrasound-guided vision to insert needles better and accurately deposit the anaesthetic – increasing the overall efficacy of

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injections.[3,4] Injection can be done unilaterally or bilaterally into the rectus muscle or through surgical and laparoscopic interventions.[3,5]

Previous reports have highlighted the RSB's potential analgesic effectiveness in managing postoperative pain but have been limited in their search and scope. They appear to present a degree of uncertainty in their findings.[6] For example, a recent 2020 review on the analgesic efficacy of the RSB investigated nine studies using postoperative pain scores as a practical endpoint but was limited in its search criteria by focusing solely on adult laparoscopic procedures.[7] In 2016, a combined analysis was performed exploring the efficacy of RSB and transverse abdominal plane blocks in children; however, despite including both laparoscopic and open abdominal surgeries, only five trials were selected for the RSB group.[8] In a more recent 2022 article, Zhen *et al*.[9] also explored the efficacy of the RSB in paediatric umbilical hernia repairs; yet again, due to their constraints, they included only four trials in their review. Since the RSB is currently recognised as a viable choice for pain relief in various abdominal procedures, and more potentially diverse randomised controlled trials (RCTs) investigating its broader efficacy have likely been published, an updated review of the literature is warranted.

In this systematic review and meta-analysis, we attempted to address the degree of uncertainty in the literature by compiling all available studies on the analgesic efficacy of the RSB following abdominal surgery. The study's objective was to assess the efficacy of the RSB in reducing postoperative pain following abdominal surgery, as compared to established anaesthetic techniques. We hypothesise that the RSB will be seen as an effective anaesthetic method for abdominal operations, outperforming conventional general anaesthesia approaches in both the reduction of postoperative pain and 24-h intravenous (IV) morphine equivalent consumption.

METHODS

Study protocol

This systematic review and subsequent meta-analysis followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocol (PRISMA-P).[10] The study protocol was registered prospectively on the International Prospective Register of Systematic Reviews (PROSPERO ID: CRD42022372596).

Inclusion and exclusion criteria

The studies included in this review were selected based on the PICOS (Population, Intervention, Comparator, Outcome and Study) framework. The population was hospitalised participants of any age who underwent an abdominal surgical procedure in which the intervention was the use of RSB. The comparator for this study was any reasonable alternative control such as placebo, wound infiltration, port-site infiltration, local anaesthetic, continuous drip infusion and epidural anaesthesia. The primary outcome was the efficacy of RSB at various reasonably spaced time points throughout postoperative recovery. The secondary outcome was 24-h IV morphine equivalent consumption. Reviews, conference abstracts, letters to the editor, systematic reviews, meta-analyses, case reports, combined blocks and non-comparative and retrospective studies were excluded.

Exclusion criteria were met if a study was irrelevant to the RSB technique, was a technical description/proceeding, utilised combined blocks, was non-randomised, did not include human models or if a study was a case report and case series. Among the publications identified, we excluded studies that did not report postoperative pain scores during at least one of the time points necessary to analyse the primary outcome.

Search strategy

We systematically explored and retrieved studies for analysis from the US National Library of Medicine database (PUBMED), Medline (Ovid), Cochrane Central Register of Controlled Clinical Studies (CENTRAL), the Elsevier Scopus Database (SCOPUS) and the Web of Science online Database (Web of Science). An additional manual search strategy was also implemented to identify studies not retrieved through electronic search, as recommended by Chapman *et al*.[11] 2010. The database and manual search were conducted by reviewer [SDJ]. Selected papers were all RCTs published from inception to 1 September, 2023. Eligibility was limited to include English language, and human participant studies only. Identification of relevant studies through title and abstract screening was subsequently performed by at least two independent reviewers [SDJ and RH] for identification of potentially eligible studies. A third reviewer [TH] was available upon request to finalise any conflicts in the study and data selection.

The basic search strategy (in titles, abstracts and/or all fields) was as follows. Search query: ALL (rectus

sheath block OR abdominal field block OR anaesthesia OR analgesia OR block OR inject OR infusion) AND ALL (randomised control trial OR controlled OR clinical trial OR randomised) – Articles type: RCT Trials only - Publication year: Inception–Sept 2023 [SDC Table 1].

Data extraction and synthesis

All studies were first collected into the Rayyan intelligent, systematic review tool for deduplication, abstract screening and initial study selection.[12] Deduplication occurred electronically, while independent reviewers manually performed initial abstract screening and study selection [SJ, RH] using predefined criteria in the attached protocol. A data collection sheet was then created with the following items extracted: authors, year of publication, surgical procedure, RSB technique, RSB timing, RSB drug, control intervention and postoperative analgesia regimen.

Following article screening, independent reviews performed a full-text review and assessment for inclusion again [SDJ, RH]. If necessary, a third blinded reviewer resolved conflicts involving inclusion between reviewers [TH]. Selected articles underwent the Grades of Recommendation, Assessment, Development and Evaluation (GRADE) guidelines to evaluate the methodological quality of evidence for pooled outcomes with three or more studies.[13] These guidelines classify the evidence for pooled outcomes using predefined criteria, such as study quality, consistency, directness, precision and publication bias.[13] A final sample of 20 studies were selected for inclusion. The risk of bias in individual studies selected was further assessed using the revised Cochrane risk-of-bias tool for randomised trials (RoB 2.0, Cochrane, Copenhagen, Denmark).[14] When one study included more than two arms, data was extracted from both experimental groups only if separate participants were used. Each comparison was treated as an independent study in these cases, maintaining the assumption of independence.[15]

Outcomes

The primary outcome was reported as the difference in pain scores at 0-2 h, 10-12 h, and 12-24 h postoperatively, measured through visual or numerical pain rating scales (0-10 scale, with 0 indicating no pain and 10 representing the worst pain imaginable). Any scale that did not fall under these criteria was appropriately converted for further analysis. The secondary outcome was measured as 24-h IV morphine equivalent consumption. Any participants who received opiates other than IV morphine had their treatment converted to IV morphine equivalents.[16,17]

Statistical analysis

Analyses were performed using the Review Manager statistical software, version 5.4.1 (Cochrane, Copenhagen, Denmark). In scenarios where continuous variables were displayed as medians, ranges or interquartile ranges, the authors calculated the mean pain score and standard deviation using the methodology described in Luo *et al*.[18] and Wan *et al*.[19] If exact data was not reported, authors were contacted; if authors did not reply, the RCT was removed from inclusion in this study. If only graphical representations of data were available, means and standard deviations would be extracted using the pixel-based computer software 'WebPlotDigitizer', an HTML5-based online tool that enables the extraction of numerical data from plot images.[20]

Continuous outcomes were pooled and assessed via standardised mean differences (SMD) in a random-effects model with a 95% confidence interval (CI). High heterogeneity was expected due to the diversity of RSB applications and methodologies in the various abdominal surgical procedures.[21] A Dersomonian and Laird, random-effects model, was thus chosen to mitigate potential heterogeneity, as the effects estimated from the different studies likely still follow a particular distribution despite not having identical parameters.[22,23] A subgroup analysis was conducted to explore potential sources of heterogeneity further and evaluate the efficacy of RSB in laparoscopic and open surgery separately. The I^2 statistic was used to describe the exact percentage of the variability in effect estimates due to heterogeneity, graded as low: <30%, moderate: 30%–60%, substantial: 60%–75% or considerable: 75%–100%.[24]

RESULTS

Search criteria and study characteristics

A summary of the PRISMA flowchart outlining study selection is shown in Figure 1. Following the systematic search, 1380 studies were retrieved for screening. After deduplication and abstract inspection, 50 full-text articles were assessed for eligibility, with 34 reports ultimately excluded. Sixteen reports were deemed acceptable for inclusion, with four included in the manual search. A final total of 20 RCTs satisfied our inclusion criteria and were included in this

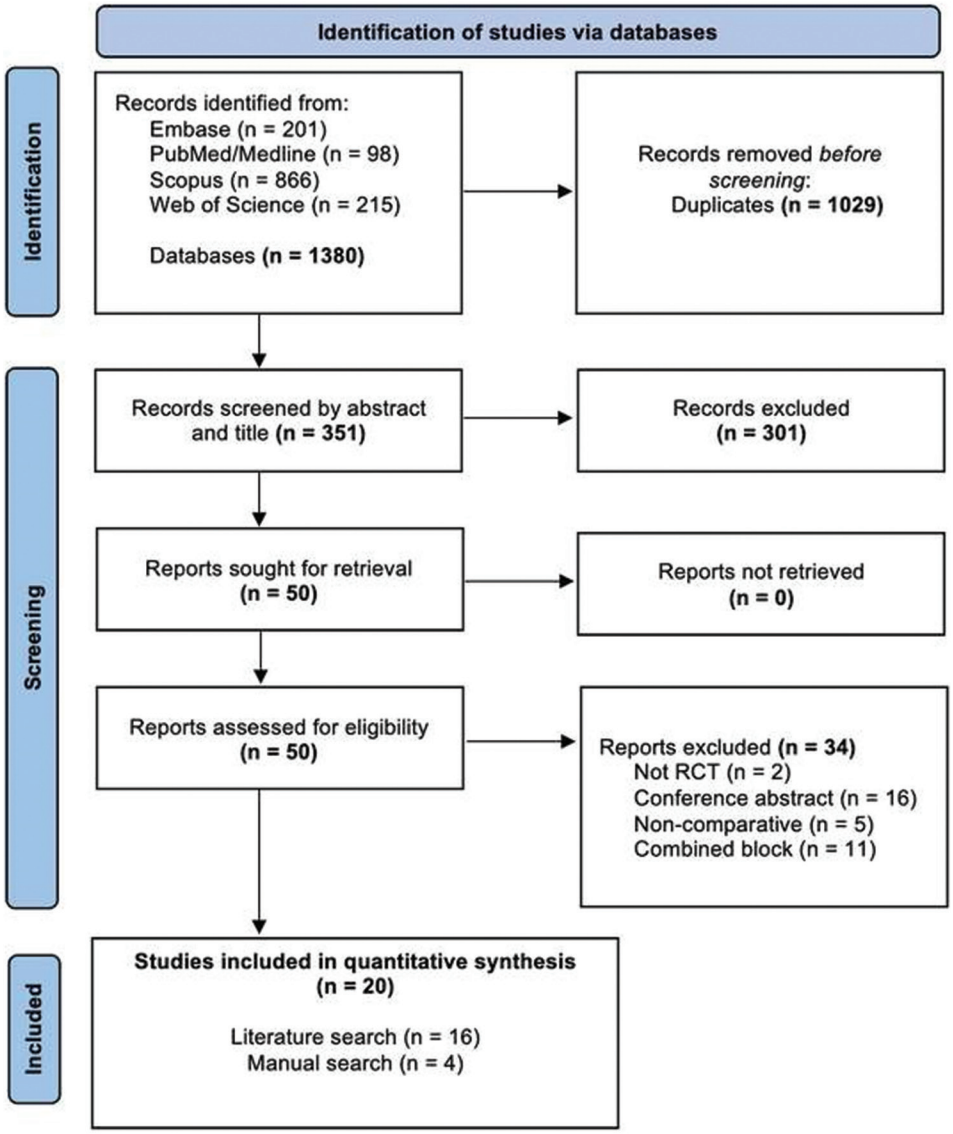

Figure 1: PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram summarising retrieved and excluded studies

analysis [Table 1].[5,25-43] The risk-of-bias analysis for all included studies is summarised in Figure 2. Details on the evidence review for the primary and secondary outcomes can be found in Table 2. A summary of the findings is displayed in Table 3.

Primary outcome: Postoperative pain scores at rest 0-2 h, 10-12 h and 12-24 h

Analysis of the continuous outcomes suggests that the RSB provides a clinically superior analgesic efficacy during the 0-2 h postoperative period when compared to control (SMD = -1.46, 95% CI [-2.04, -0.88], $P < 0.001$).[5,25-36,39,40,41,43] Heterogeneity was found to be considerable ($I^2 = 94\%$, Cochrane Q statistic $P < 0.001$). At the 10-12 h endpoint, RSB was again deemed effective in minimising postoperative pain scores (SMD -1.02, 95% CI [-1.51, -0.52], $P < 0.001$),[25,26,30-34,36-38,41,42] with heterogeneity again being considerable ($I^2 = 95\%$, Cochrane Q statistic $P < 0.001$). Finally, in the 12-24 h postoperative period, RSB was found insignificant compared to control at reducing postoperative pain scores (SMD -0.25, 95% CI [-0.55, 0.06], $P = 0.11$, $I^2 = 83\%$).[5,26,29,31,32,34,36,38-42] Heterogeneity was again considerable ($I^2 = 83\%$, Cochrane Q statistic $P < 0.001$). Details for each primary endpoint are outlined in Figure 3. Subgroup analyses are available in the attached supplemental data file [SDC Figure 1 and 2].

Secondary Outcome: 24 h IV morphine equivalent consumption

Five studies reported 24-h IV morphine equivalent consumption for nine RSB trial

Table 1: Characteristics of included studies

Study	Group Allocation	Surgical Procedure	Surgical Technique	RSB Technique	RSB Timing	RSB Drug	Control Intervention	Postoperative analgesia
Smith *et al*., 1988[25]	RSB (22) Control (24)	Diagnostic gynaecologic laparoscopy	Laparoscopic	Blind loss-of-resistance	Preop	Bupivacaine 0.25%, 30 mL	No intervention	Papaveretum
Azemati *et al*., 2005[26]	RSB (30) Control(61)	Diagnostic gynaecologic laparoscopy	Laparoscopic	Blind loss-of-resistance	Postop	Bupivacaine 0.25%, 10 mL	Port-site infiltration or intraperitoneal instillation	Not described
Isaac *et al*., 2005[27]	RSB (7) Control (6)	Umbilical hernia repair	Open	Direct insertion	Postop	Bupivacaine 0.25%, 0.15 mL/kg	Local infiltration	Morphine
Gurnaney *et al*., 2011[28]	RSB (26) Control (26)	Umbilical hernia repair	Open	Ultrasound-guided	Postop	Bupivacaine 0.25%, adjusted for weight	Local infiltration	Morphine, oxycodone
Dingeman *et al*., 2013[29]	RSB (27) Control (25)	Umbilical hernia repair	Open	Ultrasound-guided	Postop	Ropivacaine 0.20%, 0.5 mL/kg	Local infiltration	Ketorolac
Kasem *et al*., 2015[30]	RSB (23) Control (22)	LESS Cholecystectomy	Laparoscopic	Ultrasound-guided	Preop	Bupivacaine 0.25%, 20 mL	Port-site infiltration	Lornoxicam, PCA morphine
Hamill *et al*., 2015[31]	RSB (73) Control (73)	Laparoscopic appendicectomy	Laparoscopic	Ultrasound-guided	Preop	Bupivacaine 0.25%, adjusted for weight	No intervention	Paracetamol, NSAIDs
Gupta *et al*., 2016[32]	RSB (25) Control (50)	Laparoscopic Cholecystectomy	Laparoscopic	Blind loss-of-resistance	Preop	Ropivacaine 0.25%, 30 mL	No intervention or intraperitoneal instillation	Tramadol
Shah *et al*., 2016[33]	RSB (30) Control (30)	Laparoscopic tubal ligation	Laparoscopic	Ultrasound-guided	Preop	Bupivacaine 0.25%, 40 mL	No intervention	Tramadol
Chung *et al*., 2017[34]	RSB (50) Control (25)	LESS surgery for benign adnexal lesion	Laparoscopic	Ultrasound-guided, surgically guided	Postop	Ropivacaine 0.5%, 20 mL	Sham block	PCA fentanyl
Miyazaki *et al*., 2017[5]	RSB (19) Control (19)	LESS Gastrointestinal procedures	Laparoscopic	Laparoscopically guided	Postop	Levobupivacaine 0.25%, 40 mL	No intervention or epidural analgesia	Fentanyl, NSAIDs
Uchinami *et al*., 2017[35]	RSB (17) Control (17)	Laparoscopic extraperitoneal closure surgery	Laparoscopic	Ultrasound-guided	Postop	Ropivacaine 0.375%, 0.4 mL/kg	Local infiltration	Not described
Cho *et al*., 2018[36]	RSB (30) Control (30)	Laparoscopic extraperitoneal closure surgery	Laparoscopic	Ultrasound-guided	Preop	Ropivacaine 0.25%, 30 mL	No intervention	PCA fentanyl, Ketorolac
Purdy *et al*., 2018[37]	RSB (28) Control (12)	Midline laparotomy	Open	Catheter insertion	Postop	Levobupivacaine 0.25%, 0.25 mg/mL	No intervention	Oxycodone, paracetamol
Kinjo *et al*., 2019[38]	RSB (107) Control (101)	Laparoscopy for benign gynaecologic diseases	Laparoscopic	Laparoscopically guided	Postop	Ropivacaine 0.5%, 6 mL/kg	No intervention	Pentazocine, diclofenac, loxoprofen
Suragul *et al*., 2022[39]	RSB (52) Control (48)	Laparoscopic Cholecystectomy	Laparoscopic	Direct insertion	Postop	Bupivacaine 0.50%, 5 mL	No intervention	PCA Morphine
Siripruekpong *et al*., 2022[40]	RSB (32) Control (34)	Laparoscopic Tubal resection	Laparoscopic	Ultrasound-guided	Postop	Bupivacaine 0.25%, 10 mL	No Intervention	Acetaminophen
Laguduvah *et al*., 2022[41]	RSB (50) Control (50)	Midline laparotomy	Laparoscopic	Ultrasound-guided	Postop	Bupivacaine 0.25%, 15 mL	No intervention	Paracetamol, PCA Morphine
Shi *et al*., 2023[42]	RSB (30) Control (30)	Radical Gastrectomy	Laparoscopic	Ultrasound-guided	Postop	Ropivacaine 0.40%, 50 mL	Sham Block	PCA Sufentanil, Flurbiprofen axetil
Yörükoğlu *et al*., 2023[43]	RSB (30) Control (30)	Caesarean Delivery	Open	Linear Probe	Preop	Bupivacaine 0.25%, 20 mL	No intervention	PCA Morphine

PCA=Patient-controlled analgesia; NSAIDs=Non-steroidal anti-inflammatory drugs, RSB=rectus sheath block

comparisons.[30,32,34,36,37,40-42] Overall, RSB was found to provide superior postoperative consumption of analgesics in contrast to controls after 24 h (SMD = -1.55, 95% CI [-2.35, -0.74], $P < 0.001$). Heterogeneity was considered considerable (I^2 = 95%, Cochrane Q statistic $P < 0.001$). Details regarding secondary

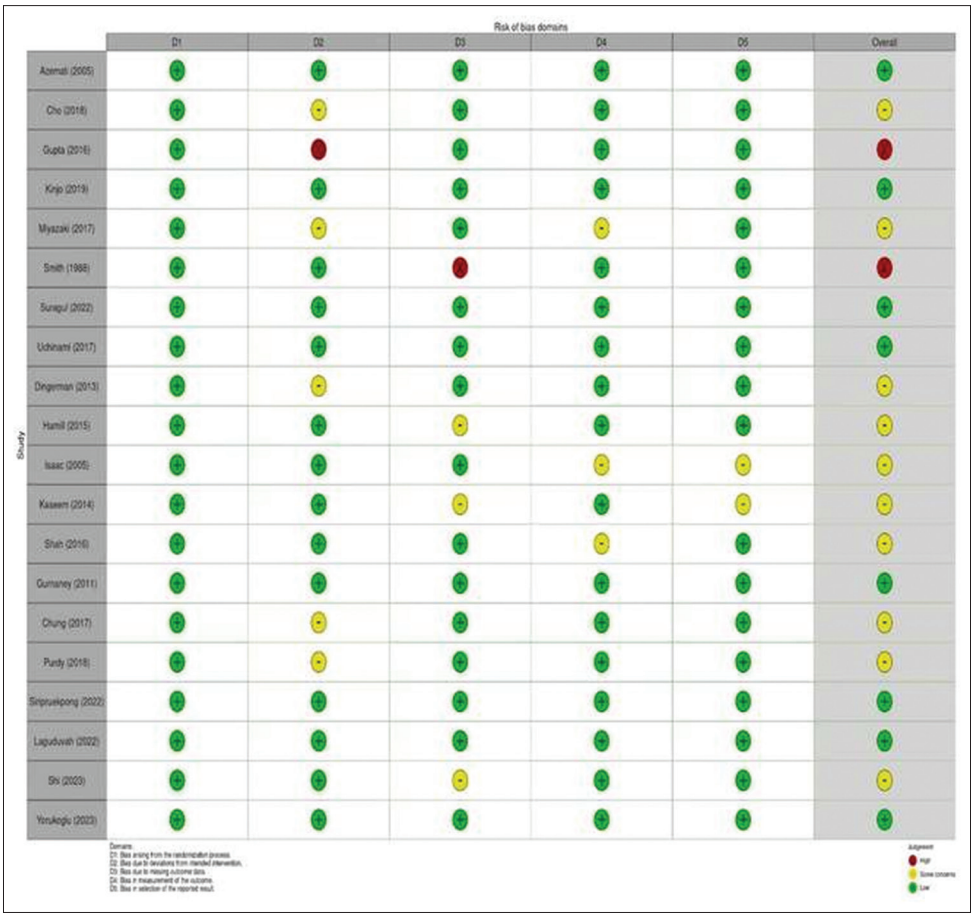

Figure 2: Summary of the revised Cochrane risk-of-bias 2.0 assessment for randomised trials

outcomes can be found in the attached supplemental data file [SDC Figure 3].

Subgroup analysis of primary outcomes: Laparoscopic vs open surgery

Further subgroup analysis suggests that the RSB continues to provide clinically superior analgesic effects independent of the surgical methods employed. During the 0-2 h postoperative period, RSB outperformed control in both open surgery (SMD -0.52, 95% CI [-0.90, -0.13], $P < 0.008$)[27-29,43] and laparoscopic surgery (SMD -1.83, 95% CI [-2.60, -1.08], $P < 0.001$).[25,26,30-36,40,41] In the open surgery subgroup, heterogeneity was considered low and not statistically significant (I^2 = 22%, Cochrane Q statistic P = 0.28). In contrast, heterogeneity in the laparoscopic surgery subgroup was considered high and statistically significant (I^2 = 96%, Cochrane Q statistic P <0.001). A test for subgroup differences found heterogeneity to be high and again statistically significant (I^2 = 88.7%, Cochrane Q statistic P = 0.003). The details of the subgroup analysis can be found in Figure 3.

Quality of evidence

In the primary outcome, the GRADE quality of evidence was rated as moderate due to inconsistencies in individual study results. For the secondary outcome, the quality of evidence was rated as low due to inconsistencies between trials and a high risk of bias. A high risk of bias arising through deviations from the intended interventions was observed in 1 of 20 (5%) studies.[32] Additionally, an increased risk of bias was observed in 1 of 20 (5%) studies, arising from missing outcome data.[25] Each outcome's Funnel plots are also available in the attached supplemental data file [SDC Figures 4-7].

DISCUSSION

The overall findings from this systematic review and meta-analysis show that when the RSB is used compared to reasonable alternative anaesthetic control, it significantly reduces postoperative pain scores up to 12 h following abdominal procedures, with increased effectiveness observed in the first 2 h following surgery. Subgroup analysis of all primary outcomes was not

Table 2: Evidence profile table of rectus sheath block vs control for patients undergoing abdominal surgery. GRADE quality of evidence is reported only when at least three studies report an outcome

Outcomes	Limitations	Inconsistency/ Heterogeneity	Indirectness	Imprecision	Publication bias	Mean difference or odds ratio [95% CI]	Number of participants (studies)	Quality or certainty of the evidence (GRADE)
Pain at rest 0-2 h postoperatively, assessed with VAS score: 0–10 (worst)	No serious limitations	I^2 Test for Heterogeneity 94% and *P*<0.00001	Potential indirectness*	Not detected	Not detected	-1.46 [-2.04, -0.88]	1154 (17 studies)[5,25-36,39,40,41,43]	⊕⊕⊕◯ MODERATE
Pain at rest 10-12 h postoperatively, assessed with VAS score: 0–10 (worst)	No serious limitations	I^2 Test for Heterogeneity 93% and *P*<0.00001	Potential indirectness*	Not detected	Not detected	-1.02 [-1.51, -0.52]	1082 (12 studies)[25,26,30-34,36-38,41,42]	⊕⊕⊕◯ MODERATE
Pain at rest 12-24 h postoperatively, assessed with VAS score: 0–10 (worst)	No serious limitations	I^2 Test for heterogeneity 83% and *P*<0.00001	Potential indirectness*	Not detected	Not detected	-0.25 [-0.55, 0.06]	1079 (12 studies)[5,26,29,31,32,34,36,38-42]	⊕⊕⊕◯ MODERATE
Oral Morphine equivalent consumption 24 h (mg)	No serious limitations	I^2 Test for Heterogeneity 95% and *P*<0.00001	Potential indirectness*	Not detected	Not detected	-1.55 [-2.35, -0.74]	619 (9 studies)[30,33,34,36,37,40-43]	⊕⊕⊕◯ MODERATE

*Direct evidence consists of research that directly compares the interventions in which we are interested, delivered to the populations in which we are interested and measures outcomes important to patients. Indirectness may be present because patients recruited to studies mostly had non-tissue preserving breast surgery compared to tissue-preserving breast surgery and/or breast surgery with reconstruction likely in modern practice. GRADE=Grading of Recommendations, Assessment, Development and Evaluations; CI=Confidence Interval

Table 3: Summary of findings table

Outcomes	RSB Mean Pain score (SD)	Control Mean Pain score (SD)	Mean difference [95% Confidence Interval]	Number of participants (studies)	Quality or certainty of the evidence (GRADE)	Comments
Pain at rest 0-2 h postoperatively, assessed with VAS score: 0–10 (worst)	2.5 (1.2)	4.2 (1.6)	-1.46 [-2.04, -0.88]	1154 (17 studies)[5,25-36, 39,40,41,43]	⊕⊕⊕◯ MODERATE	High heterogeneity; I^2 Test for Heterogeneity 94% and *P*<0.00001
Pain at rest 10-12 h postoperatively, assessed with VAS score: 0–10 (worst)	2.3 (1.2)	3.3 (1.2)	-1.02 [-1.51, -0.52]	1082 (12 studies)[25,26,30-34,36-38,41,42]	⊕⊕⊕◯ MODERATE	High heterogeneity; I^2 Test for Heterogeneity 93% and *P*<0.00001
Pain at rest 12-24 h postoperatively, assessed with VAS score: 0–10 (worst)	2.3 (1.3)	2.6 (1.2)	-0.25 [-0.55, 0.06]	1079 (12 studies)[5,26,29,31,32,34,36,38-42]	⊕⊕⊕◯ MODERATE	High heterogeneity; I^2 Test for Heterogeneity 83% and *P*<0.00001
Oral Morphine equivalent consumption, 24 h (mg)	8.6 (3.6)	12.9 (4.5)	-1.55 [-2.35, -0.74]	619 (9 studies)[30,32,34,36,37,40-43]	⊕⊕◯◯ LOW	High heterogeneity; I^2 Test for Heterogeneity 95% and *P*<0.00001

Population: Patients undergoing abdominal surgery; Intervention: Rectus sheath block; Comparator: Control (parenteral analgesia). SD=standard deviation; VAS=visual analogue scale. GRADE (Grading of Recommendations Assessment, Development and Evaluation) Working Group grades of evidence. High certainty: We are very confident that the true effect lies close to that of the estimate of the effect. Moderate certainty: We are moderately confident in the effect estimate. The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different. Low certainty: Our confidence in the effect estimate is limited. The true effect may be substantially different from the estimate of the effect. Very low certainty: We have very little confidence in the effect estimate. The true effect is likely to differ substantially from the estimate of the effect

possible due to a limited data set, but subgroup analysis findings within the 0-2 h postoperative period revealed that the analgesic effectiveness of the RSB remains regardless of the choice between open or laparoscopic intervention. Moreover, the use of RSB appears to significantly reduce postoperative opioid use up to 24 h following surgical intervention. Based on our results, the RSB should be considered an effective nerve block consideration for abdominal surgical procedures. Similar findings were demonstrated by Hamid *et al*. in 2021[7]

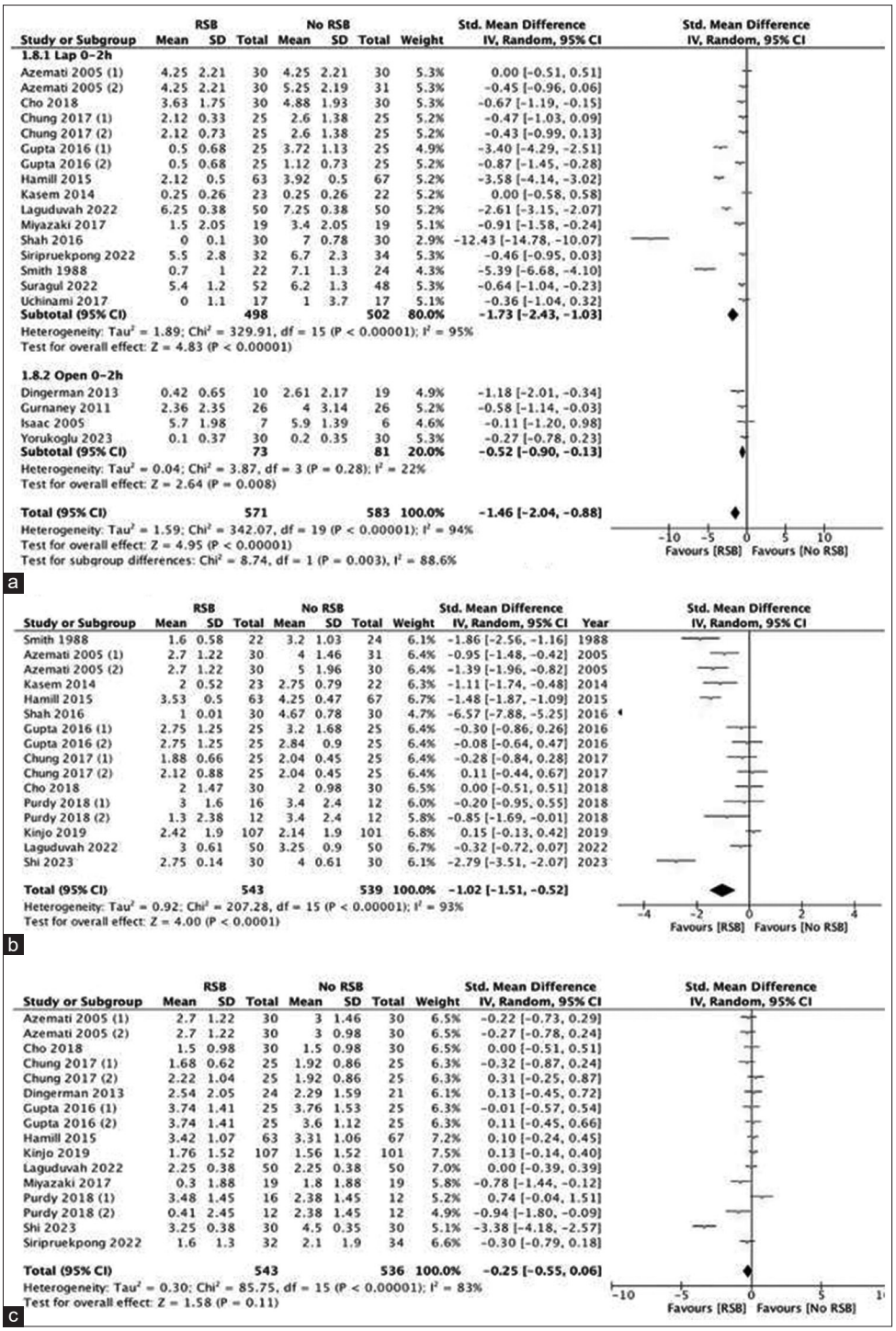

Figure 3: Forest plot demonstrating overall RSB performance compared to control, (a) 0-2 h, (b) 10-12 h, and (c) 12-24 h postoperatively. The random-effects model was used to review studies with continuous variables. Standardised mean ratios are presented with 95% confidence intervals. RSB = rectus sheath block, CI = Confidence Interval, SD = Standard Deviation. *Numbers in parentheses delineate separate groups when more than one cohort was under investigation in a given trial

and Zhen *et al*. in 2022,[9] but the methodologies of these findings were limited to adult laparoscopic surgery and paediatric umbilical hernia repairs, respectively.

Increasing the breadth of knowledge upon which to draw through our inclusion of all relevant surgical procedures in which the RSB may now be utilised, we have therefore here expanded on previous findings in the literature by conducting the most comprehensive RSB review to date and believe that the RSB should continue to be considered an effective treatment measure for not just laparoscopic

interventions, but all relevant abdominal surgical procedures.

Abdominal peripheral nerve blocks are currently seen as adequate and reliable methods for the treatment of adult and paediatric postoperative pain following both open and laparoscopic abdominal procedures.[44,45] Despite epidural or intrathecal methods being the current gold standard, certain situations may arise where an epidural approach is either not possible or unnecessary.[3] With its cost-effectiveness, ease of use and rising popularity due to relatively low complication rates since the inception of ultrasound guidance, the RSB should be considered an ideal choice when such situations present themselves.[46] Here, we confirmed previous results published on the RSB's efficacy in abdominal procedures while bridging the gap in the literature between open and laparoscopic RSB usage, highlighting its more comprehensive applications and building on previous findings in more specialised surgery domains. We recommend that the RSB be used in instances where appropriate for abdominal procedures in which no other analgesic intervention has been considered, particularly for minor operations with high postoperative pain management needs and a low average time to discharge.

Despite the robust nature of our review, several limitations existed within our study parameters. First, several issues related to reporting and obtaining data from all the trials included. Some studies did not report pain scores during our allotted time intervals, others did not collect discernable data during those intervals, and others used non-opioid analgesics for postoperative pain or did not report analgesic use at all. This strict inclusion criteria limited the author's ability to report on all studies. Still, the inclusion criteria were designed to reduce heterogeneity and bias by focussing on a set level of objective metrics where possible. Funnel plots were additionally generated for the primary and secondary outcomes [SDC Figures 4-7]. The graphical representation presents a visual of the extent of publication bias. A relatively symmetrical shape in all figures representing the primary outcomes suggests little publication bias in continuous results. Yet, it is more significant in secondary analysis outcomes due to less symmetry. In circumstances where multiple groups were included in one study and could lead to a potential unit-of-analysis issue through the influence of the control group data weighting, care was taken to maintain the independence of each comparison where possible by treating each intervention group separately.

Unfortunately, a high degree of heterogeneity between the studies analysed was still observed. This high degree of heterogeneity likely reflects the many differing types of surgical procedures employed, type of local anaesthetic utilised, timing of the block, postoperative analgesia chosen and differences in control regimens. These effects were also likely exacerbated by the differences in participant comorbidities, age and some level of self-reporting bias. Our search strategy was designed to capture a comprehensive range of studies in RSB, including those that employ varied surgical techniques. This inclusive approach aimed to provide a meta-analysis reflecting the current evidence state across clinically relevant applications. We implemented this strategy to give a detailed insight into current practice and future research trajectories. We attempted to further decrease heterogeneity by analysing subgroup outcomes based on the type of surgical intervention. However, levels were still seen as high in the laparoscopic subgroup – limiting the power of meta-analytic results. However, this degree of heterogeneity was expected and is consistent with other previous peripheral nerve block review findings reported in the literature.[7-9]

During this review, we identified some areas for future research. A clear focus should be put into the RSB's efficacy in comparison to other newer and widely utilised abdominal nerve blocks such as the quadratus lumborum block, erector spinae plane block, ilioinguinal-iliohypogastric block, pericapsular nerve group block and transversalis fascia plane block. Researchers should also consider implementing more in-depth timing of pain scores to determine better how long the efficacy of a nerve block truly is, rather than relying on large, open-ended time periods as is currently commonplace. Additionally, it should become standard practice to be more transparent in reporting such findings. These small changes would increase the ability of researchers to aggregate larger sums of data on nerve block efficacy so that patient populations may benefit from an increased number of included studies in future reviews. Finally, the comparative efficacy of ultrasound, laparoscopic, blind loss-of-resistance and surgically guided techniques in RSB implementation need to be explored once enough data on the subject is available.

CONCLUSIONS

We conclude that the rectus sheath block may be a safe and effective intervention for reducing surgical pain in abdominal procedures, with a heightened efficacy noted in the initial 2 h postoperatively. Implementation of rectus sheath block was additionally associated with decreased opioid consumption, in intravenous morphine equivalency, for up to 24 h following surgical intervention. Moderate-low evidence and substantial statistical heterogeneity were observed in the 20 trials included in this review. Further high-quality research is required to reach an optimal benefit assessment of rectus sheath block.

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Nil.

Conflicts of interest

RH and TMH are Shareholders of Divocco AI, Montreal, Canada.

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SUPPLEMENTAL DATA CONTENT (SDC)

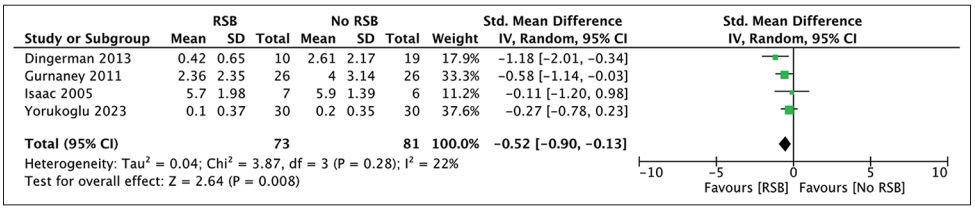

Figure 1: Forest plot demonstrating open surgery subgroup analysis of RSB performance compared to control 0-2 h postoperatively

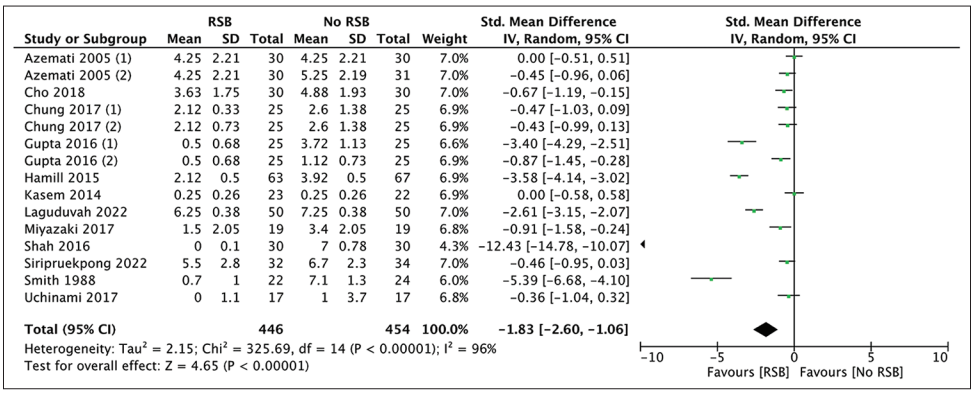

Figure 2: Forest plot demonstrating laparoscopic surgery subgroup analysis of RSB performance compared to control 0-2 h postoperatively. SD = standard deviation, CI = confidence interval

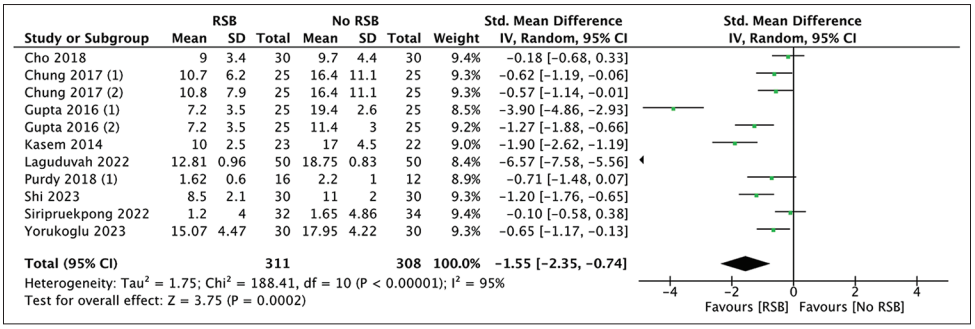

Figure 3: Forest plot demonstrating overall RSB performance compared to control in 24-h IV morphine equivalency (mg). SD = standard deviation, CI = confidence interval

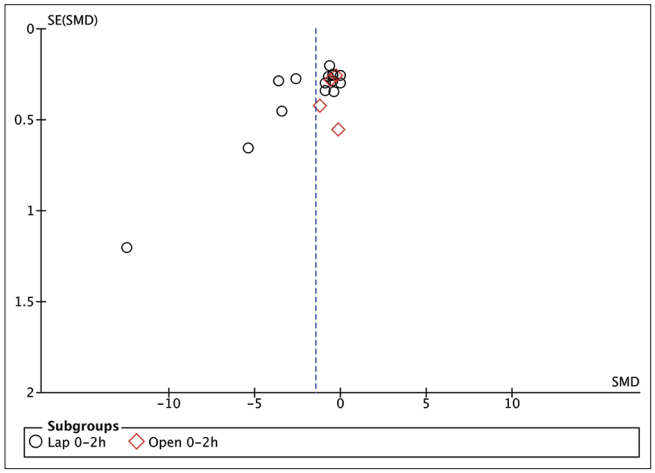

Figure 4: Funnel plot of primary outcome: Pain assessment at 0-2 h postoperatively

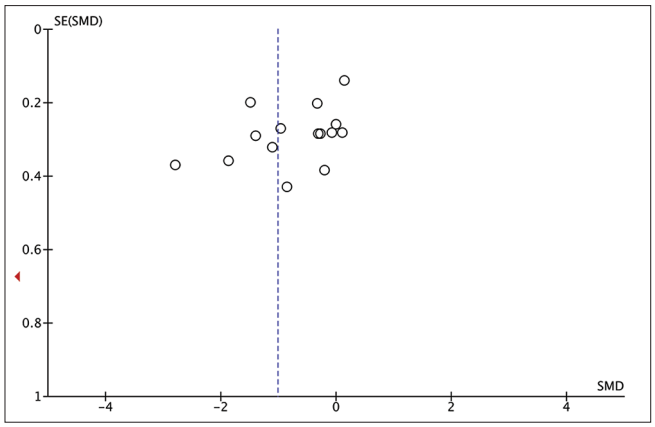

Figure 5: Funnel plot of primary outcome: Pain assessment at 10-12 h postoperatively

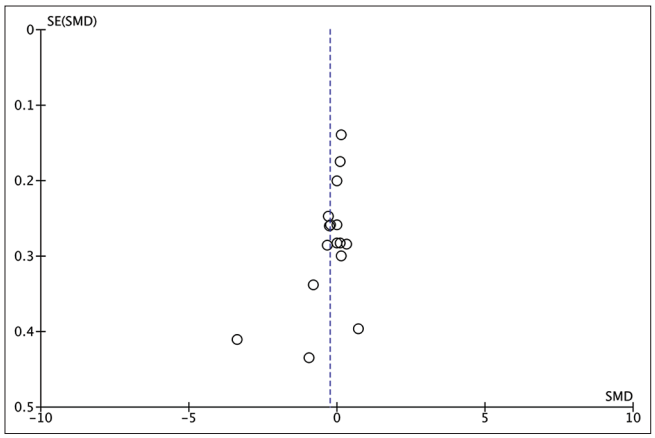

Figure 6: Funnel plot of primary outcome: Pain assessment at 12-24 h postoperatively

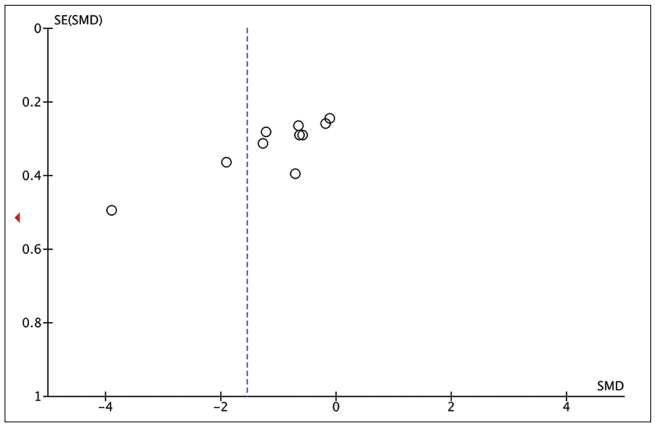

Figure 7: Funnel plot of secondary outcome: Morphine equivalency at 24 h

Table 1: Example of detailed search strategy Embase <1996 to 2023 Week 36>		
#	Query	Results from 1 Sept 2023
1	Rectus sheath block.mp.	374
2	abdominal field block.mp.	15
3	1 or 2	386
4	anaesthesia/	83,645
5	analgesia/	135,534
6	block.mp.	336,306
7	inject.mp.	13,570
8	infusion/	63,528
9	4 or 5 or 6 or 7 or 8	604,074
10	randomised controlled trial/	748,474
11	controlled.mp.	10,161,878
12	clinical trial/	940,132
13	randomised.mp.	1,364,560
14	10 or 11 or 12 or 13	10,728,293
15	3 and 9 and 14	201