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RECTUS SHEATH BLOCK IN ABDOMINAL SURGERY: A SYSTEMATIC REVIEW WITH META-ANALYSIS

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Abstract

Background and aims: *With the development of ultrasound-guided and laparoscopic techniques of rectus sheath block (RSB), regional analgesia promises to be efficient and safe. However, studies show controversial results. Our systematic review with meta-analysis aims to evaluate the effect of rectus sheath block in abdominal surgery.*
Method: *We searched PubMed, Google Scholar, and the Cochrane Library from inception to October 2021 for randomised controlled trials written in English. We included studies on adult populations undergoing abdominal surgery. The primary outcomes of our meta-analysis were postoperative pain intensity and postoperative opioid consumption. Data analysis was conducted using the Review Manager software (RevMan, v. 5.4). Statistical heterogeneity was estimated by the I^2 statistic. The methodological quality of the included studies was assessed using the Oxford quality scoring system (Jadad Scale).*
Results: *Eight randomised controlled trials (RCTs) in English with a total of 386 patients were included in this meta-analysis. Patients in the RSB group did not consume fewer anaesthetics and opioids after abdominal surgery when compared with patients in the control group. In addition, postoperative pain intensity (out of 10) was not lower in the RSB group when compared with the control group. Finally, RSB did not improve the time to the first opioid/analgesic (min) compared with the non-RSB option.*
Conclusion: *There is no statistically significant evidence in favour of RSB over non-RSB in reducing anaesthetics and opioid consumption, postoperative pain intensity, and increasing time to first opioid/analgesic.*

Keywords

rectus sheath block • abdominal surgery • opioid consumption • postoperative pain intensity • time to first opioid

Introduction

One of the major concerns of abdominal surgery patients is postoperative pain and its complications. Poorly controlled postoperative pain not only affects patient recovery but can also increase postoperative opioid use and potential abuse. Contraindications, complications, and the cost of neuraxial analgesia, which is widely used for abdominal surgery, require the exploration of alternative analgesia modalities [1]. Administration of local anaesthetics rather than opioids makes regional analgesia a promising modality for abdominal surgery [2].

Truncal nerve blocks offer relative simplicity and safety of analgesia in abdominal surgery [3]. One of the most common truncal nerve blocks is the transversus abdominis plane (TAP) block, which targets thoracolumbar nerves [3]. All other developed blocks, such as the rectus sheath block (RSB), are often compared against the TAP block.

RSB targets terminal branches of thoracic nerves [4] and is indicated mainly for surgeries with midline vertical incisions [3]. With the evolvement of ultrasound-guided and laparoscopic approaches, RSB promises to be safer now than the former blind approach [4]. These new administration modes reduce not only the mechanical complications of RSB but also the systemic toxicity of local anaesthetics [5]. A couple of systematic reviews demonstrated the efficacy and safety of RSB in the paediatric population [6, 7]. On the other hand, adult studies demonstrated controversial results [1, 4]. Several regional anaesthetic

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techniques targeting postoperative pain in abdominal surgery have been developed and studied over the past several years [8, 9].

To establish the most appropriate method for postoperative pain management based on the highest level of evidence, the comparison of different methods of regional anaesthesia in the framework of meta-analyses is required.

In this systematic review with meta-analysis, we aimed to explore the efficiency and safety of RSB in abdominal surgery.

Methods

Protocol

We developed a protocol for meta-analysis regarding the inclusion and exclusion criteria for appropriate articles. The protocol and methods were agreed upon by all authors. We sought RCTs in English that studied the effect of RSB in abdominal surgery. We used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)" [10].

One of the authors searched for relevant articles in PubMed, Google Scholar, and the Cochrane Library that were published before October 2021 (Figure 1). The following search terms or their combination were used during the search: "rectus sheath block", "abdominal surgery", "hepatobiliary surgery", "liver surgery", "hernia surgery", "laparotomy", "caesarean section", "C-section".

Participants and population

Inclusion criteria:

1) Randomised controlled trials (RCTs);
2) Surgery: abdominal surgery;
3) Comparators: RSB vs. control;
4) Articles published in English.

Exclusion criteria:

1) Non-RCTs: retrospective studies, case reports, case series, editorials, cadaver studies, technical reports;
2) Not adequately described study methodology, assessment, reporting methods.

Outcomes

The primary outcomes of our meta-analysis are postoperative pain intensity and postoperative opioid consumption.

Data extraction and statistical methods

We extracted and entered data in the data table. Means and standard deviations of continuous data were entered

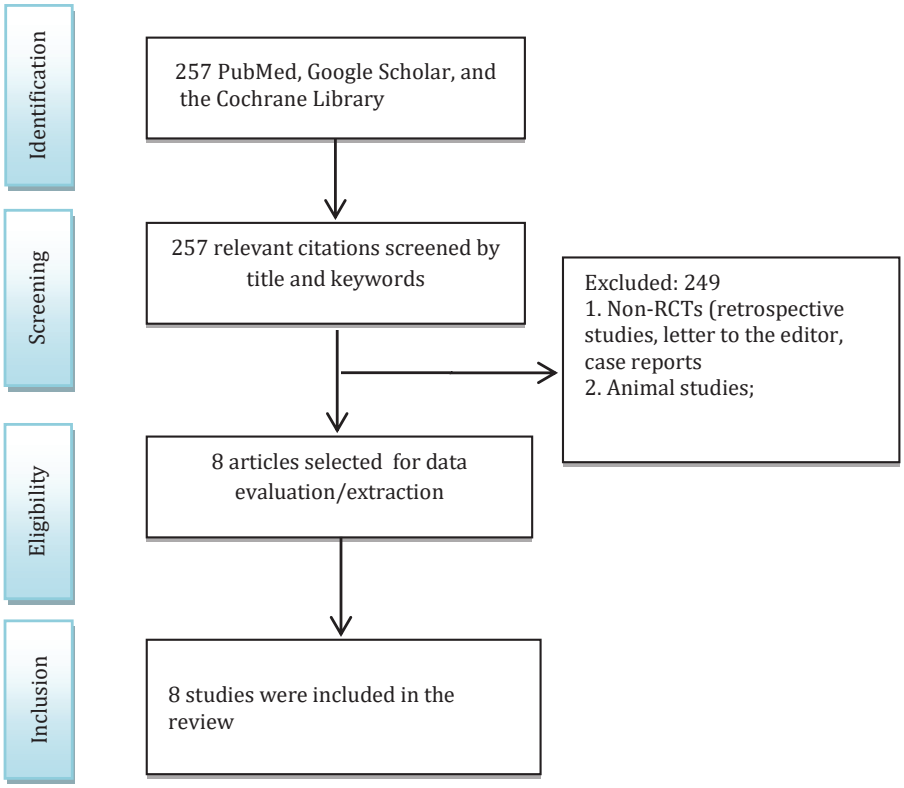

Figure 1. PRISMA diagram

in the table. The following rubrics were included: reference, first author, year of publication, country, design and goals of the study, age of participants, type of surgery, sample size, American Society of Anesthesiologists (ASA) physical status, pharmacological agents and adjuvants, and side effects. Data analysis was conducted using the Review Manager software (RevMan, v. 5.4). Data were analysed via mean difference with 95% CIs, using random effects meta-analysis. Statistical heterogeneity was estimated by the I^2 statistic. Data for morphine equivalent conversions are taken from:

1. Equianalgesic opioid conversions. Retrieved from https://cdn-links.lww.com/permalink/jpsn/a/jpsn_4_2_2015_04_23_manworren_jpsn-d-14-00050r2_sdc1.pdf
2. Opioid conversion ratios (February 2021). Retrieved from https://www.safercare.vic.gov.au/sites/default/files/2021-02/GUIDANCE_Opioid%20Conversion%20FINAL_0.pdf
3. BCGuidelines.ca. (2017). Equianalgesic Conversion for Morphine. Retrieved from https://www2.gov.bc.ca/assets/gov/health/practitioner-pro/bc-guidelines/palliative2_-_pain_equianalgesic.pdf

Assessment of methodological quality

The methodological quality of the included studies was assessed using the Oxford quality scoring system (Jadad Scale) [11]. The quality of the studies was graded within the range from 1 to 5 as low (<3), acceptable (3), good (4), and excellent (5).

Results

We found 18 articles that matched our search criteria (Figure 1). Eight articles [2, 12–18] with 386 patients (RSB group – 192 and control group – 194) and were selected for meta-analysis (Table 1).

Anaesthetics and opioids consumption (in morphine equivalents, mg/kg)

The anaesthetics and opioid consumption data (in milligrams of morphine equivalents per kilogram) are depicted in the forest plot below (Figure 2). The overall effect of the model does not favour RSB over control, and the result is not sensitive to the exclusion of any study (standardized mean difference [SMD] with 95% CI: 0.16 [–1.82, 2.14]). The model shows considerable heterogeneity (I^2 = 97%). There were 81 patients in the RSB group and 86 in the control group.

Pain intensity (out of 10)

The overall effect of the model (Figure 3) does not favour RSB over control (SMD with 95% CI: –0.09 [–0.39, 0.22]). We should note that in one study[14] the value of sample standard deviation was zero, so the results of this study were not estimable. However, when zero is replaced by a non-zero value (0.1), the model favours the experimental group.

Time to first opioid/analgesic request (min)

The postoperative time to first opioid/analgesic request (min) was reported in four studies. The overall effect of the model (Figure 4) does not favour RSB over the control (SMD with 95% CI: –0.81 [–3.37, 1.75]). The model shows high heterogeneity (I^2 = 98%).

Assessment of methodological quality (Oxford quality scoring system [Jadad Scale]) (Table 2)

Discussion

Our review included eight RCTs from Europe, Northern America, and Asia. Each study supported the efficacy of RSB; however, in our meta-analysis, RSB did not significantly improve pain scores compared to the control. There was no significant difference between RSB and the control in total opioid requirement or in the time to the first opioid request. These results can be explained by the limited analgesic effects of RSB, which cannot substantially improve visceral pain, but rather aims to relax the abdominal wall [3]. There was high heterogeneity for opioid use and low heterogeneity for pain control.

Our results align with the network meta-analysis by Howle et al. [1], which compared various regional analgesia modalities in laparotomic surgeries between January 2010 and January 2021. The authors found that single-shot RSB was superior to the control regarding pain relief only shortly after the surgery but not in the first 24 hours postoperatively. In contradiction, continuous RSB administration demonstrated better results in both pain control and opioid-sparing effects during the first day after surgery [1]. Hamid et al. [4] described laparoscopic studies up to October 2020 and revealed decreased opioid consumption but not pain scores during the first postoperative day in RSB patients. The different surgical approaches studied in these two meta-analyses could influence the difference in opioid use.

Regarding meta-analyses evaluating paediatric studies, Hamill et al. [6] demonstrated that combined RSB and TAP did not reduce opioid use or pain during the first 24 hours. Similar to Howle et al [1], the benefits of the blocks could be seen only immediately after the surgery [6]. All studies

Table 1: Characteristics of included studies

Author, citation	Country	Study design	Study goals	Age	Number of patients: total (intervention/ control)	Group	Surgery	General anesthesia	ASA	Local anesthetics, volume and concentration	Adjuvants to local anesthetics
Cho et al., 2018	South Korea	RCT	Primary: postoperative VNRS pain scores, total number of rescue analgesics used in 48 hours after the operation	21-60 Mean (SD): Intervention – 39.6(9.8) Control – 41.7(11.3)	60 (30/30)	Intervention: ultrasound-guided RSB Control: no block	Gynecologic laparoscopic surgery	Yes	I-II	7.5 mL 0.25% ropivacaine bilaterally	Fentanyl, ketorolac
Cowlishaw et al., 2017	-	RCT	Analgesic and antiemetic consumption, pain scores (VAS), nausea, vomiting, and satisfaction	54-56	88 (29/29/30) - (SC/PRS/TAP)	Intervention: TAP – transversus abdominis plane catheter, PRS – posterior rectus sheath catheter, SC – subcutaneous catheter	Midline Laparotomy surgery	No	-	18 mL 0.5% ropivacaine via catheter	Dexamethasone, Metoclopramide, Paracetamol, NSAIDs
Kartalov et al., 2017	North Macedonia	RCT	Primary: VAS pain scores, total morphine dose over 24 hours	Mean (SD): Intervention – 41.3(15.8) Control – 42.4(14.7)	60 (30/30)	Intervention: general anesthesia with RSB Control: no block	Umbilical hernia repair surgery	Yes	I-II	20 mL 0.25% bupivacaine bilaterally	Paracetamol, morphine IV
Kauffman et al., 2020	USA	RCT	Primary: pain score 60 minutes after the PACU arrival Secondary: pain (PACU), length of PACU stay, outpatient pain scores, outpatient opioid use, adverse events.	10-21 Total: 15.3(3.1), control: 15.8(1.6), intervention: 14.83(4.0)	48 (24/24)	Intervention: laparoscopic-guided RSB. Control: trans-incisional RSB	Single-incision laparoscopic cholecystectomy surgery (gallbladder removal)	Yes	I-II	0.5 mL/kg 0.2% ropivacaine hydrochloride bilaterally (total 1 mL/kg, total maximum dose 10 mL)	Ondansetron IV, dexamethasone, glycopyrrolate
Li et al., 2019	China	RCT	Primary: incidence of positive hemodynamic response at incision, incidence of moderate pain postoperatively Secondary: intraoperative sufentanyl, time to eye opening, time to extubation, time to oxycodone request, duration of sensory block	46-70 Mean (SD): Group B – 58.0 (8.3), Group C – 56.4 (8.6), Group D – 58.7 (7.1), Group BD – 57.1 (8.3)	85 (66/19) 1 control group: 19 (Group C) 3 intervention groups: 22 (Group B), 21 (Group D) and 23 (Group BD)	Intervention: ultrasound-guided RSB (Group B), dexmedetomidine infusion (Group D), both RSB and dexmedetomidine (Group BD) Control: nothing (Group C)	Open gastrectomy surgery (stomach removal)	Yes	I-III	Group B: 20 mL 0.375% ropivacaine diluted in 0.9% saline bilaterally only Group D: initial dose 0.6 µg/kg dexmedetomidine followed by continuous infusion 0.2 µg/kg/h during surgery then followed by 10 µg sufentanyl Group BD: combination of Group B analgesics first followed by Group D analgesics	Dexmedetomidine, sufentanyl

(*Continued*)

Table 1. Continued

Author, citation	Country	Study design	Study goals	Age	Number of patients: total (intervention/ control)	Group	Surgery	General anesthesia	ASA	Local anesthetics, volume and concentration	Adjuvants to local anesthetics
Murouchi et al., 2015	USA	RCT	Concentration changes of Ropivacaine and analgesic effects	18-85	22 (11/11)	Intervention: RSB Control: TAPB	laparoscopic ovarian surgery	Yes	I-II	30mL 0.5% ropivacaine bilaterally, 15mL per side	droperidol, acetaminophen
Xu et al., 2018	China	RCT	Primary: effectiveness and safety	75-77	60 (30/30) – (R+D / R)	Intervention: R+D (10mL 0.25% ropivacaine + 0.5 μg/kg dexmedetomidine); R (10 mL 0.25% ropivacaine)	Emergency abdominal surgery	Patient-controlled intravenous analgesia (PCIA)	II-III	10 mL 0.25% ropivacaine, + 0.5 μg/kg dexmedetomidine bilaterally	Sufentanil, Cardiovascular medications
Yentis et al., 1999	UK	RCT	Pain scores, morphine requirements	32-71	37(21/16)	Intervention: midline incisions Control: transverse incisions	abdominal gynecological surgery	Yes	I-II	Up to 60 ml bupivacaine 0.25%	adrenaline 1:400 000

ASA – American Society of Anesthesiologists
RCT – randomized controlled trial
PACU – postanesthesia care unit
RSB – rectus sheath block
VAS – visual analog scale
VNRS – verbal numerical rating scale

included in this meta-analysis used ultrasound-guided RSB. Winnie et al. [7] compared RSB with normal saline and local anaesthetics alone and concluded that RSB could reduce morphine consumption and pain scores in paediatrics better than the control. However, the mean difference between the groups was less than one on the 0–10 scale, which is not clinically significant. A decrease in pain scores after surgery can be considered clinically significant if the difference is more than 20 out of 100, or 2 out of 10 in our case [19]. Zhen et al. [20] compared RSB to local anaesthetics for umbilical hernia repairment in children and found no difference between the groups in terms of pain scores and analgesia use after surgery. Outcomes in the paediatric population were expected to be different from those in adults due to the adjustment of the anaesthetic dose to the weight of children. Nevertheless, the aforementioned systematic reviews demonstrated similar results between these populations.

The decision regarding the use of regional blocks depends on balancing the risks and benefits of these methods. One of the most life-threatening complications of regional anaesthesia is local anaesthetic systemic toxicity. Previous reports showed that anterior abdominal wall blocks could lead to detectable plasma concentrations that might exceed the acceptable thresholds of local anaesthetic systemic toxicity [5]. Therefore, anaesthesiologists should always be aware of the risks of local anaesthetic systemic toxicity [21], and if the regional anaesthesia method does not result in the reduction of pain scores or the dose of opioids, the use of such methods becomes questionable.

Our meta-analysis has several limitations. First, two studies with a high risk of bias were included in this study (Table 2). Second, the pooled population demonstrated high heterogeneity. One of the main sources of heterogeneity is the comparison group, which could be TAP block; RSB block, but with another technique; or nothing. The RSB techniques were also different among the studies: ultrasound, laparoscopic, or blind approaches were used. Another source of heterogeneity is surgery and its approach. Both laparoscopic and open surgeries were compared. The setting and conditions were also quite different among the studies: there were emergency and elective surgeries, and gynaecological and gastrointestinal conditions. Different age groups could also contribute to high heterogeneity: we included studies in children, adults, and the elderly. Finally, different doses and regimens of general and local anaesthetics can influence the outcomes. As a result, we could not compare some other important outcomes, such as safety and recovery.

Conclusion

Rectus sheath block (RSB) did not reduce opioid consumption (in morphine equivalents) after abdominal surgery.

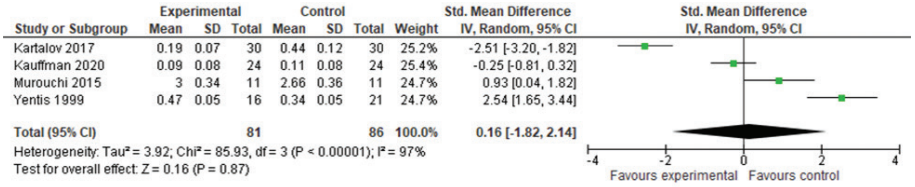

Figure 2. Anaesthetics and opioids consumption (in morphine equivalents, mg/kg).

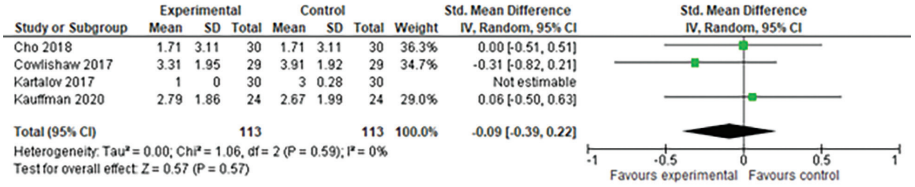

Figure 3. Pain intensity (out of 10).

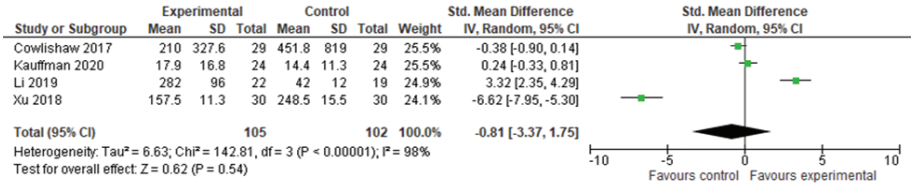

Figure 4. Time to first opioid/analgesic request (min).

Table 2: Jadad Scale

Study or subgroup	Was this study described as randomized?	Was the method used to generate the sequence of randomization appropriate and described?	Was the study described as double-blind?	Was the method of double blind appropriate and described?	Was there a description of withdraw and dropouts?	Total score
Cho 2018	1	1	0	0	1	3
Cowlishaw 2017	1	1	1	1	1	5
Kartalov 2017	1	0	1	0	0	2
Kauffman 2020	1	0	1	1	1	4
Li 2019	1	1	1	1	1	5
Murouchi 2015	1	0	0	0	0	1
Xu 2018	1	1	1	0	1	4
Yentis 1999	1	1	1	0	0	3

Postoperative pain intensity was not lower in the RSB group when compared with the control group. RSB did not prolong the time to the first opioid/analgesic request compared to the non-RSB option. Therefore, there is no statistically significant evidence in favour of RSB over non-RSB treatment options. Due to the heterogeneity across the studies, it was not possible to compare some other important outcomes. The sensitivity analysis showed that the results of this meta-analysis are not sensitive to the exclusion of studies.

Implications for further research

These results are based on a small number of studies, and more randomized controlled trials are needed to evaluate the same outcomes – postoperative pain and opioid use. Other

outcomes, such as the length of the hospital stay, quality of recovery (mobilisation, recovery of gastrointestinal function), and side effects would be of value as well.

Implications for practice

Currently, RSB does not seem to be superior to placebos for pain control or opioid use reduction after abdominal surgeries for either adults or paediatrics.

Acknowledgments

None.

Conflict of interest

None declared.

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