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Ultrasound-guided subcostal approach of transversus abdominis plane block compared with wound infiltration for postoperative analgesia following laparoscopic cholecystectomy

A systematic review and meta-analysis

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Abstract

Background: Despite laparoscopic cholecystectomy (LC) is a commonly performed operation under ambulatory setting, significant postoperative pain is still a major concern. The ultrasound-guided subcostal approach of transversus abdominis plane (sTAP) blocks and wound infiltration (WI) are both widely practiced techniques to reduce postoperative pain in patients undergoing LC. Although these methods have been shown to relieve postoperative pain effectively, the relative analgesic efficacy between ultrasound-guided sTAP blocks and WI is not well known.

Methods: We searched PubMed, EMBASE, and CENTRAL to identify all randomized controlled trials (RCTs) comparing ultrasound-guided sTAP block versus WI for postoperative pain control in adult patients undergone LC. The search was performed until May 2023. Primary outcome was defined as 24-hour cumulative opioid consumption. Secondary outcomes were postoperative pain scores and the incidence of postoperative nausea and vomiting (PONV).

Results: Finally, 6 RCTs were included, and data from 314 participants were retrieved. Postoperative 24-hour opioid consumption was significantly lower in ultrasound-guided sTAP group than in the WI group with a mean difference of –6.67 (95% confidence interval: –9.39 to – 3.95). The ultrasound-guided sTAP group also showed significantly lower pain scores. Incidence of PONV did not significantly differ between the 2 groups.

Conclusions: We conclude that there is low to moderate evidence to advocate that ultrasound-guided sTAP block has better analgesic effects than WI in patients undergoing LC. Further trials are needed with robust methodology and clearly defined outcomes.

Abbreviations: CI = confidence intervals, GRADE = grades of recommendation, assessment, development, and evaluation, IV = intravenous, LC = laparoscopic cholecystectomy, MD = mean differences, OR = odds ratio, PONV = postoperative nausea and vomiting, RCTs = randomized controlled trials, sTAP = subcostal approach of TAP, TAP = transversus abdominis plane, WI = wound infiltration.

1. Introduction

Laparoscopic cholecystectomy (LC) is a frequently performed upper abdominal surgery that has an increasing day-case rate.[1] Postoperative pain is a common cause of delayed discharge after ambulatory surgery.[2,3] Since acute pain following LC is multifactorial, multimodal analgesic techniques are recommended in clinical practice.[2] Although various modalities have been attempted to relieve postoperative pain after LC, significant

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The authors have no conflicts of interest to disclose.

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

The predefined protocol was registered in the International Prospective Register of Systematic Reviews (CRD42021254121).

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postoperative pain remains a major concern interfering with early discharge.[2–4]

As a part of multimodal analgesia techniques, the posterior or lateral approach of transversus abdominis plane (TAP) block is becoming a trend for anesthesiologists in lower abdominal surgeries. Recently, subcostal approach of TAP (sTAP) block has been recognized as particularly necessary in upper abdominal surgery because it provides sensory blockage of anterior rami of the spinal nerves from T6 to T9.[5,6] These nerves supply the muscles and skin of the supra-umbilical abdomen.[5] Wound infiltration (WI), another multimodal analgesia techniques, is local anesthetics (LA) infiltration into the trocar sites and is commonly performed by surgeons.[7] It is also known as a simple and effective method for providing analgesia after LC.[8,9]

Several meta-analyses have provided evidence that both TAP block and WI deliver superior postoperative analgesic effects after LC when compared to placebo.[10,11] Recent meta-analysis comparing TAP block and WI reported that TAP block provides superior analgesia when compared with WI in patients undergone LC.[12] However, the efficacy of conventional posterior or lateral approach of TAP block may not be suitable for pain control after LC as it only reliably produces analgesia below the umbilicus.[5,13] Therefore, we designed and conducted a systematic review and meta-analysis of randomized controlled trials (RCTs) to determine which method provided superior postoperative analgesic effect between ultrasound-guided sTAP and WI following LC.

2. Materials and methods

2.1. Protocol and registration

The authors performed the systematic review and meta-analysis according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline.[14] The predefined protocol was registered in the International Prospective Register of Systematic Reviews (CRD42021254121).

2.2. Eligibility criteria

All RCTs evaluating the effects of ultrasound-guided sTAP block compared with port site infiltration on postoperative pain after LC were included. There were no restrictions on publication year, language, and region. The authors excluded nonrandomized studies of intervention, case reports, letters to editors, review articles, and animal studies. The primary outcome was defined as cumulative opioid consumption at 24-hour after surgery. The secondary outcomes included pain scores at 2, 6, 12, and 24-hour after surgery and the incidence of postoperative nausea and vomiting (PONV). We estimated mean differences (MD) and odds ratio (OR) using a random-effects model.

2.3. Sources and search

Two authors (SP and JP) independently conducted a literature search (PubMed, EMBASE, and CENTRAL) to identify all RCTs evaluating the analgesic efficacy of ultrasound-guided sTAP block in patients undergoing LC. The search terms consisted of Medical Subject Headings terms and keywords, including "transversus abdominis plane" and "TAP." Each result was combined by the Boolean operator "AND" or "OR." Detailed search terms for each database are shown in Table S1, Supplemental Digital Content, http://links.lww.com/MD/M327. The search was performed until May 2023.

2.4. Study selection, data collection process, and data items

Two authors (SP and JHP) independently read the titles and abstracts of the articles to remove obviously irrelevant studies. Subsequently, the full texts of the articles were retrieved and reviewed to include studies that met the aim of this study. Data from the final included articles were extracted and summarized in a spreadsheet by 2 independent authors (SP and JHP). If a consensus could not be reached, a third reviewer (JNJ) assessed the data and made the final decision. The extracted data included first author, publication year, sample size, LA, patient-controlled analgesia consumption, pain scores, and the incidence of PONV. In addition, GetData Graph Digitizer 2.26 (http://www.getdata-graph-digitizer.com) was used to digitize and extract the data from the graph. Any discrepancy was settled by discussion with the corresponding authors (SP and JHP).

2.5. Risk of bias in individual studies

Two independent authors (SP and JHP) assessed the quality of the final included articles using the Cochrane Collaboration tool for assessing risk of bias for RCT,[15] which consists of randomization process, deviations from intended interventions, missing outcome data, measurement of the outcome, and selection of the reported. Each bias was graded as low, unclear, or high. If a discrepancy occurred, a third reviewer (JNJ) made the final decision.

2.6. Quality of the evidence

We evaluated the quality of evidence for each outcome using the Grades of Recommendation, Assessment, Development, and Evaluation (GRADE) approach.[16] The following five categories were examined: risk of bias, consistency, directness, imprecision, and reporting bias. RCTs began as high-quality of evidence. They were rated down based on the described criteria. The quality of evidence was classified as high (further research is very unlikely to change our confidence in the estimate of effect), moderate (further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate), low (further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate), or very low (we are very uncertain about the estimate).

2.7. Summary measures and synthesis of results

Statistical analyses were conducted using Review Manager 5.3 (Nordic Cochrane Center, Cochrane Collaboration, Copenhagen, Denmark). For continuous variables, MD and 95% confidence intervals (CI) were calculated. If data were expressed as the median and range (minimum to maximum or interquartile range), the mean and standard deviation were estimated using Wan formula.[17] For dichotomous variables, OR and 95% CI were calculated. A continuity correction of 0.5 was applied to zero total event RCTs, which means that no patients in both groups experienced the outcome event.[18] A random-effects model was employed due to the anticipated clinical between-study heterogeneity. In case the number of combined studies was lower than 10, the Hartung–Knapp–Sidik–Jonkman method was used in the random-effects analysis to minimize the error rate.[19] Funnel plot for included studies was presented in Figure S1, Supplemental Digital Content, http://links.lww.com/MD/M328. The results of the meta-analysis were presented by a forest plot. An I^2 statistic estimated the degree of heterogeneity among the final included articles. It was interpreted as no (0%–25%), low (25%–50%), moderate (50%–75%), or high (75%–100%). All opioids were converted to equi-analgesic intravenous (IV) morphine doses

(IV morphine 10 mg = oral morphine 30 mg = IV hydromorphone 1.5 mg = oral hydromorphone 7.5 mg = IV pethidine 75 mg = oral oxycodone 20 mg = IV tramadol 100 mg).[20] For pain scores reported through an 11-point verbal, visual, or numeric rating scale, we transposed the results to a 0 to 10 analog scale to permit statistical evaluation.

2.8. Sensitivity analysis

We performed sensitivity analyses if uncertainty remained concerning the clinically homogeneity of studies compared.

3. Results

3.1. Identification of studies

A total of 380 articles were retrieved from the literature search. After removing 126 duplicated manuscripts, 254 studies remained. Subsequently, 243 irrelevant articles were excluded after screening the titles and abstracts and 11 studies were eligible for inclusion. After reading the full-text articles, 5 articles were excluded from the final analysis and 6 studies with 314 patients were included in the final analysis (Fig. 1). About 157 patients were allocated to the TAP group, and 157 patients were allocated to the WI group. Details of each RCT are summarized in Table 1.[21–26]

3.2. Risk of bias

The risk of bias is reported in Figure 2. The main contributor to high risk of bias was due to deviations from intended interventions with 5 trials. In those studies, patients received either TAP block or WI, and thus these patients or practitioners could recognize whether TAP or WI had been performed or not.

3.3. Primary outcome

Postoperative cumulative opioid consumption was reported in 6 RCTs, including 314 patients. Opioid consumption was significantly lower in the sTAP block group than in the WI group (MD −6.67, 95% CI −9.39 to −3.95, $P < .001$) (Fig. 3). A high level of heterogeneity was observed among the studies ($I^2 = 95\%$; $P < .001$).

3.4. Secondary outcomes

The pain score at 2 hours was reported in 6 RCTs, including 314 patients and 6-, 12-, 24-hour pain scores were reported in 5 RCTs, including 271 patients (Table 2). The pain scores at 4 different time points after surgery are reported in Figure 4. At all-time points, significantly lower pain scores were reported by patients receiving TAP blocks compared with those receiving WI treatment and heterogeneity was moderate to high. The incidence of PONV was reported in 4 RCTs, including 228 patients. The incidence of PONV was comparable between the 2 groups (OR: 0.58, 95% CI: 0.23–1.44, $P = .24$) (Fig. S2, Supplemental Digital Content, http://links.lww.com/MD/M329). A low level of heterogeneity was found among the studies.

3.5. GRADE assessment

For the outcome of cumulative morphine consumption, there was low to moderate-quality evidence which was downgraded due to inconsistency, imprecision and publication bias. For pain intensity as the outcome, there was low to moderate-quality evidence which was downgraded due to inconsistency and imprecision. For PONV as the outcome, there was moderate-quality evidence which was downgraded due to inconsistency imprecision and publication bias.

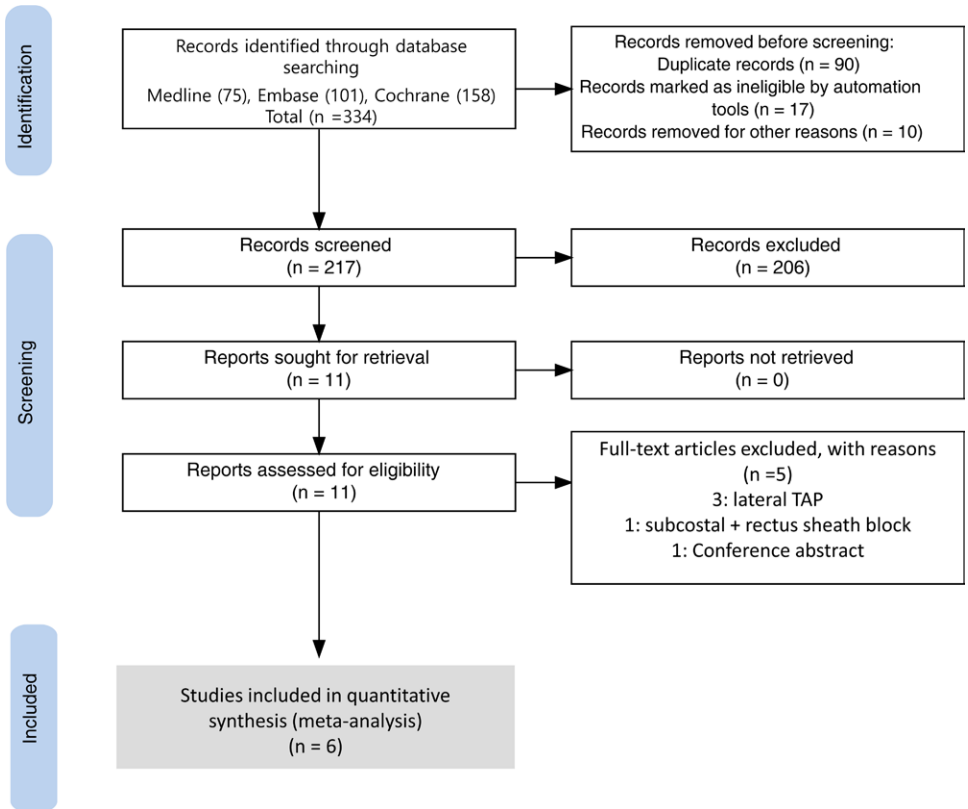

Figure 1. Flow chart of database search and study selection.

Table 1

Characteristics of the studies included in the systemic reviews and meta-analysis.

Study	Group	Treatment	Postoperative analgesia
Arık 2020[21]	Unilateral sTAP (n = 24) WI (n = 24) Control (n = 24)	20 mL 0.25% bupivacaine	iv paracetamol, tramadol at the end of surgery iv PCA of tramadol without basal infusion iv rescue dexketoprofen
Baral 2019[22]	Bilateral sTAP (n = 30) WI (n = 30)	20 mL 0.25% bupivacaine	iv paracetamol q 6 h iv rescue pethidine
Ibrahim 2020[23]	Bilateral sTAP (n = 21) WI (n = 21) ESP (n = 21)	40 mL 0.25% bupivacaine	iv opioid at PACU iv paracetamol q 6 h iv PCA of morphine without basal infusion
Ramkiran 2018[24]	Unilateral sTAP (n = 21) PSI (n = 20) TAP + RSB (n = 20)	20 mL 0.25% bupivacaine	iv rescue tramadol 50 mg
Suseela 2018[25]	Bilateral sTAP (n = 40) PSI (n = 40)	40 mL 0.25% bupivacaine	iv paracetamol q 8 iv rescue tramadol and diclofenac
Tolchard 2012[26]	Unilateral sTAP (n = 21) PSI (n = 22)	1 mg/kg 0.25% bupivacaine	iv fentanyl, iv paracetamol, iv diclofenac, rescue im morphine, rescue oral codeine

ESP = erector spinae plane block, PACU = post-anesthetic care unit, PCA = patient-controlled analgesia, RSB = PSI, sTAP = subcostal transversus abdominis plane block, WI = wound infiltration.

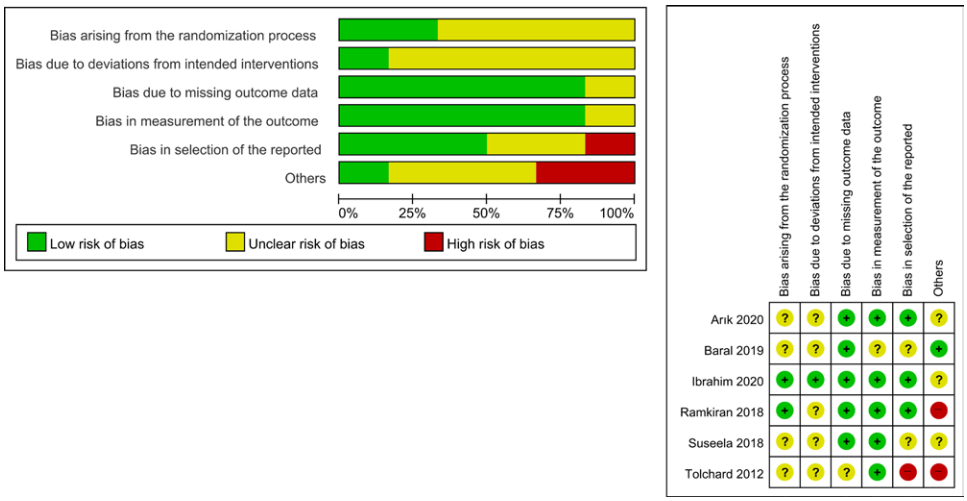

Figure 2. Cochrane collaboration risk of bias summary: evaluation of bias risk items for each included study. Green circle, low risk of bias; red circle, high risk of bias; yellow circle, unclear risk of bias.

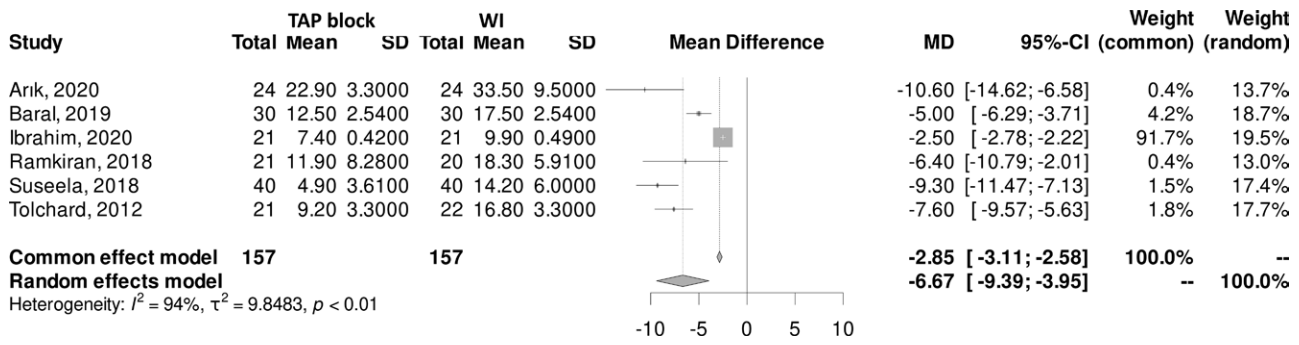

Figure 3. Forest plot for postoperative 24-h opioid consumption. CI = confidence interval, MD = mean difference, SD = standard deviation, TAP = transversus abdominis plane.

3.6. Sensitivity analysis

To identify potential outlier trials contributing to the observed heterogeneity and detect the outcome stability, a leave-one-out method was used whereby we repeated the meta-analysis with a random-effects model iteratively removing studies. The study by Ibrahim et al was identified as an outlier (Fig. 5). None of the other individual studies eliminated the large heterogeneity.

4. Discussion

This meta-analysis revealed that ultrasound-guided sTAP blocks lead to reduce postoperative 24-hour opioid consumption for patients undergoing LC compared to WI. Pain scores up to 24-hour were also significantly lowered. However, there was no significant reduction in PONV compared to WI.

The important finding of this study is that ultrasound-guided sTAP block reduced postoperative opioid consumption compared to WI. Multimodal analgesia is focused on reducing opioid use because it interferes with postoperative recovery and early discharge.[27,28] In addition, opioid-related adverse events were related to poor outcomes, including increased inpatient mortality, prolonged length of hospital stay, and higher 30-day readmission rates.[27,29] Our results are concordant with previous studies which demonstrated that both TAP block and WI reduced 24-hour opioid consumption compared to placebo group.[10,11]

Recently, Grape et al[12] reported systematic review based on 10 RCTs included a total of 668 patients and demonstrated TAP block reduces pain scores and IV morphine consumption up to 24 hours compared to WI in patients undergone LC. In that study, however, various types of TAP block including posterior and lateral approach, subcostal approach, and laparoscopic-guided technique, were included. TAP block and sTAP block are currently recognized as effective techniques to provide analgesia above and below the umbilicus, respectively. The efficacy of classical posterior and lateral approach TAP block might not suitable for upper abdominal surgery

Table 2

Secondary pain-related outcome.

Outcome	Studies	Participants	Mean difference [95% CI]	I^2 (%)	*P* value
Pain score at 2 h	6	314	−0.70 [−1.28, −0.12]	87	.02
Pain score at 6 h	5	271	−0.89 [−1.52, −0.25]	73	.006
Pain score at 12 h	5	271	−0.99 [−1.54, −0.44]	69	.0004
Pain score at 24 h	5	271	−0.73 [−1.16, −0.29]	60	.0001

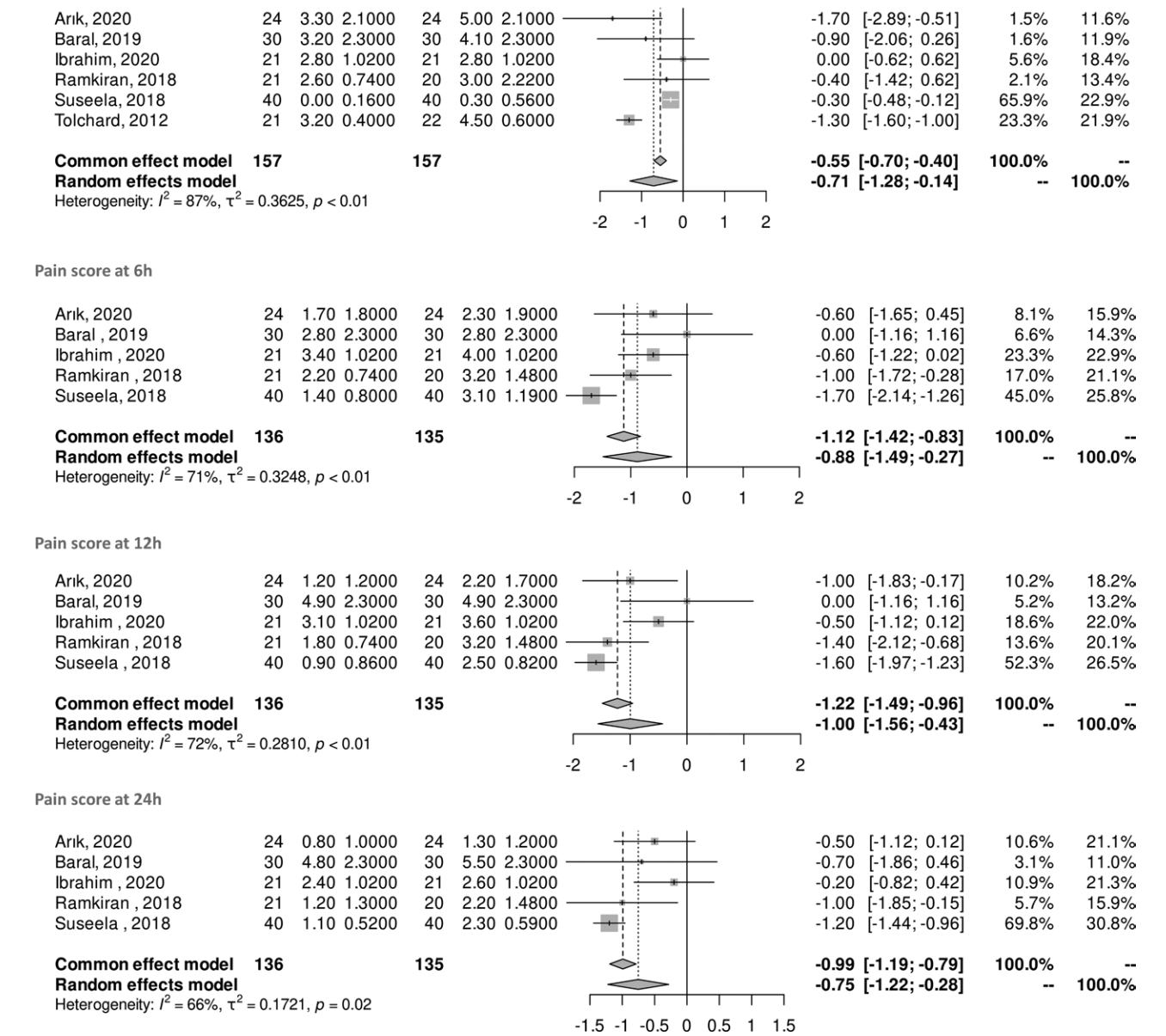

Figure 4. Forest plot for postoperative pain scores. CI = confidence interval, MD = mean difference, SD = standard deviation, TAP = transversus abdominis plane.

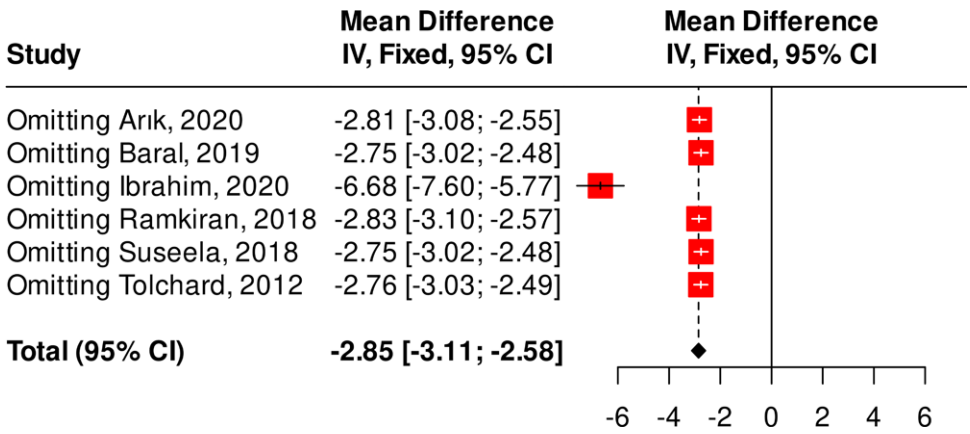

Figure 5. Sensitivity analysis.

including LC.[30] As classical TAP block provides sensory blockage of segmental nerves from T10 to L1,[31] it has only reported to be reliable for providing analgesia below the umbilicus.[32] Because of the different anatomical distributions of the anesthetics in the 2 block methods, adjustment of the study inclusion was necessary. Therefore, we included only RCTs where TAP block was performed with subcostal approach and ultrasound guidance. Therefore, our findings are meaningful in that we compared methods of pain control only above umbilicus, the incision site for LC. Additionally, we included more updated 2 RCTs that were missing from previous systematic reviews.

Postoperative pain following LC has a complexity which is either due to visceral pain (caused by the trauma of gallbladder resection) or cutaneous and muscular pain (caused by the skin and muscle incision at trocar sites).[2,3,33] Hence, a multimodal analgesic technique should be employed.[2,34] Thus, both sTAP block and WI are somatosensory nerve block and could not cover all kinds of pain following LC. All of studies included used IV paracetamol or NSAID as a multimodal analgesia which may have covered the visceral components of pain.

Although postoperative pain after abdominal surgery is multifactorial, incisional pain dominated in incidence and intensity.[3,32] The incisional pain is prominent in the first 24 to 48 hours postoperatively and the most common location of the pain is the right upper quadrant and the port sites.[3] A promising approach for providing postoperative analgesia after an abdominal incision is to block sensory nerve supply to the anterior abdominal wall.[32] Unlike classical TAP block, the needle insertion point of sTAP block, is near the xiphoid process.[5] And then, the needle is directed inferno-laterally parallel to the costal margin and the local anesthetic is deposited between transversus abdominis and the rectus abdominis muscles. Ultimately, it provides sensory blockage of anterior rami of the spinal nerves from T6 to T9.

The conventional WI is a blind technique that blocks sensory nerves of the anterior abdominal wall. The degree of sensory nerve block might be unpredictable due to the lack of clearly defined anatomic landmarks and the analgesic duration of WI lasted only 2 to 3 hours after the end of surgery.[2] Although this method is widely used, relevant studies regarding the analgesic effect are lacking. On the other hand, ultrasound-guided sTAP block ensures accurate deposition of LA in the correct interfascial plane and the analgesic effect of a single-shot TAP block lasts up to 36 hours, which might be related to the slow drug clearance in TAP where relatively poorly vascularized.[35]

This study has several limitations. First, a relatively small sample size was included in the RCTs. This could be the reason for the lack of significance of results such as PONV. Second, dermatomal sensory testing of the block was not performed in all RCTs. Thus, the success or failure rate of TAP remains unknown, and this may have influenced the results of our study. Third, although we converted the doses of various types of opioids to morphine-equivalent doses, we cannot completely rule out the effect of different types of opioids on our results. Fourth, blinding of performance was not adequately performed in many studies. Except for 1 study, 1 of the 2 blocks was implemented. Therefore, there is a possibility that it may influence performance of clinicians. Finally, there is possible publication bias, as only studies published in peer-reviewed journals were included.

5. Conclusion

We conclude that there is low to moderate evidence to reveal that ultrasound-guided sTAP block has better opioid-sparing effects than WI in patients undergoing LC. Ultrasound-guided sTAP block may be considered as an important component of multimodal analgesia.

Author contributions

Conceptualization: Sukhee Park, Ji-Hoon Park, Soyoon Park, Jae Ni Jang.
Data curation: Young-Soon Choi.
Funding acquisition: Sukhee Park.
Investigation: Sukhee Park, Soyoon Park, Chaeeun Kim.
Methodology: Young-Soon Choi.
Resources: Soyoon Park.
Supervision: Sukhee Park.
Writing – original draft: Sukhee Park, Jae Ni Jang.
Writing – review & editing: Sukhee Park, Ji-Hoon Park.

References

[1] Clarke MG, Wheatley T, Hill M, et al. An effective approach to improving day-case rates following laparoscopic cholecystectomy. Minim Invasive Surg. 2011;2011:564587.
[2] Bisgaard T. Analgesic treatment after laparoscopic cholecystectomy: a critical assessment of the evidence. Anesthesiology. 2006;104:835–46.
[3] Bisgaard T, Klarskov B, Rosenberg J, et al. Characteristics and prediction of early pain after laparoscopic cholecystectomy. Pain. 2001;90:261–9.
[4] Jensen K, Kehlet H, Lund CM. Post-operative recovery profile after laparoscopic cholecystectomy: a prospective, observational study of a multimodal anaesthetic regime. Acta Anaesthesiol Scand. 2007;51:464–71.
[5] Hebbard P. Subcostal transversus abdominis plane block under ultrasound guidance. Anesth Analg. 2008;106:674–5; author reply 675.
[6] Ma N, Duncan JK, Scarfe AJ, et al. Clinical safety and effectiveness of transversus abdominis plane (TAP) block in post-operative analgesia: a systematic review and meta-analysis. J Anesth. 2017;31:432–52.
[7] Scott NB. Wound infiltration for surgery. Anaesthesia. 2010;65:67–75.

[8] Papagiannopoulou P, Argiriadou H, Georgiou M, et al. Preincisional local infiltration of levobupivacaine vs ropivacaine for pain control after laparoscopic cholecystectomy. Surg Endosc. 2003;17:1961–4.
[9] Pappas-Gogos G, Tsimogiannis KE, Zikos N, et al. Preincisional and intraperitoneal ropivacaine plus normal saline infusion for postoperative pain relief after laparoscopic cholecystectomy: a randomized double-blind controlled trial. Surg Endosc. 2008;22:2036–45.
[10] Loizides S, Gurusamy KS, Nagendran M, et al. Wound infiltration with local anaesthetic agents for laparoscopic cholecystectomy. Cochrane Database Syst Rev. 2014:CD007049.
[11] Peng K, Ji FH, Liu HY, et al. Ultrasound-guided transversus abdominis plane block for analgesia in laparoscopic cholecystectomy: a systematic review and meta-analysis. Med Princ Pract. 2016;25:237–46.
[12] Grape S, Kirkham KR, Akiki L, et al. Transversus abdominis plane block versus local anesthetic wound infiltration for optimal analgesia after laparoscopic cholecystectomy: a systematic review and meta-analysis with trial sequential analysis. J Clin Anesth. 2021;75:110450.
[13] Shibata Y, Sato Y, Fujiwara Y, et al. Transversus abdominis plane block. Anesth Analg. 2007;105:883.
[14] Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. BMJ. 2009;339:b2535.
[15] Sterne JAC, Savović J, Page MJ, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. BMJ. 2019;366:l4898.
[16] Schünemann HJ, Oxman AD, Brozek J, et al. GRADE: assessing the quality of evidence for diagnostic recommendations. Evid Based Med. 2008;13:162–3.
[17] Wan X, Wang W, Liu J, et al. Estimating the sample mean and standard deviation from the sample size, median, range and/or interquartile range. BMC Med Res Methodol. 2014;14:135.
[18] Friedrich JO, Adhikari NK, Beyene J. Inclusion of zero total event trials in meta-analyses maintains analytic consistency and incorporates all available data. BMC Med Res Methodol. 2007;7:5.
[19] IntHout J, Ioannidis JP, Borm GF. The Hartung-Knapp-Sidik-Jonkman method for random effects meta-analysis is straightforward and considerably outperforms the standard DerSimonian-Laird method. BMC Med Res Methodol. 2014;14:25.
[20] Albrecht E, Guyen O, Jacot-Guillarmod A, et al. The analgesic efficacy of local infiltration analgesia vs femoral nerve block after total knee arthroplasty: a systematic review and meta-analysis. Br J Anaesth. 2016;116:597–609.
[21] Arık E, Akkaya T, Ozciftci S, et al. Unilateral transversus abdominis plane block and port-site infiltration: comparison of postoperative analgesic efficacy in laparoscopic cholecystectomy. Anaesthesist. 2020;69:270–6. Unilaterale Transversus-abdominis-plane-Blockade und Port-site-Infiltration: Vergleich der postoperativen analgetischen Wirksamkeit bei laparoskopischer Cholezystektomie.
[22] Baral B, Poudel PR. Comparison of analgesic efficacy of ultrasound guided subcostal transversus abdominis plane block with port site infiltration following laparoscopic cholecystectomy. J Nepal Health Res Counc. 2019;16:457–61.
[23] Ibrahim M. Erector spinae plane block in laparoscopic cholecystectomy, is there a difference? A randomized controlled trial. Anesth Essays Res. 2020;14:119–26.
[24] Ramkiran S, Jacob M, Honwad M, et al. Ultrasound-guided combined fascial plane blocks as an intervention for pain management after laparoscopic cholecystectomy: a randomized control study. Anesth Essays Res. 2018;12:16–23.
[25] Suseela I, Anandan K, Aravind A, et al. Comparison of ultrasound-guided bilateral subcostal transversus abdominis plane block and port-site infiltration with bupivacaine in laparoscopic cholecystectomy. Indian J Anaesth. 2018;62:497–501.
[26] Tolchard S, Davies R, Martindale S. Efficacy of the subcostal transversus abdominis plane block in laparoscopic cholecystectomy: comparison with conventional port-site infiltration. J Anaesthesiol Clin Pharmacol. 2012;28:339–43.
[27] de Boer HD, Detriche O, Forget P. Opioid-related side effects: postoperative ileus, urinary retention, nausea and vomiting, and shivering. A review of the literature. Best Pract Res Clin Anaesthesiol. 2017;31:499–504.
[28] Bonnet F, Marret E. Influence of anaesthetic and analgesic techniques on outcome after surgery. Br J Anaesth. 2005;95:52–8.
[29] Shafi S, Collinsworth AW, Copeland LA, et al. Association of opioid-related adverse drug events with clinical and cost outcomes among surgical patients in a large integrated health care delivery system. JAMA Surg. 2018;153:757–63.
[30] Ortiz J, Suliburk JW, Wu K, et al. Bilateral transversus abdominis plane block does not decrease postoperative pain after laparoscopic cholecystectomy when compared with local anesthetic infiltration of trocar insertion sites. Reg Anesth Pain Med. 2012;37:188–92.
[31] Tran TM, Ivanusic JJ, Hebbard P, et al. Determination of spread of injectate after ultrasound-guided transversus abdominis plane block: a cadaveric study. Br J Anaesth. 2009;102:123–7.
[32] McDonnell JG, O'Donnell B, Curley G, et al. The analgesic efficacy of transversus abdominis plane block after abdominal surgery: a prospective randomized controlled trial. Anesth Analg. 2007;104:193–7.
[33] Mitra S, Khandelwal P, Roberts K, et al. Pain relief in laparoscopic cholecystectomy – a review of the current options. Pain Pract. 2012;12:485–96.
[34] Bisgaard T, Kehlet H, Rosenberg J. Pain and convalescence after laparoscopic cholecystectomy. Eur J Surg. 2001;167:84–96.
[35] McDonnell JG, Curley G, Carney J, et al. The analgesic efficacy of transversus abdominis plane block after cesarean delivery: a randomized controlled trial. Anesth Analg. 2008;106:186–91, table of contents.