

Original Article

The effect of transversus abdominis plane block for pain after laparoscopic cholecystectomy: a meta-analysis of randomized controlled trials

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Abstract: Pain after laparoscopic cholecystectomy is disadvantage to patients. Transversus abdominis plane (TAP) block technique is reported an effective analgesia after laparoscopic cholecystectomy in recent years. We conducted this meta-analysis to evaluate the effect of TAP block for pain after laparoscopic cholecystectomy. Two reviewers searched the major medical databases for eligible Randomized clinical trials. We analyzed eight included articles and found that patients received TAP block resulted in significantly less analgesic consumption during the first 24 hours (MD = -4.63; 95% CI -7.14 to -2.11; P = 0.0003). VAS pain scores at 6 h and 24 h at rest were significantly decreased in TAP block group (MD = -1.89; 95% CI -3.07 to -0.70; P = 0.002, MD = -1.31; 95% CI -2.12 to -0.50; P = 0.002 respectively), as well as VAS pain scores at 6 h on moving (MD = -0.98; 95% CI -1.62 to -0.34; P = 0.003). While pain scores at 24 h on moving were insignificant (MD = -0.99; 95% CI -2.11 to -0.14; P = 0.09). To concluded, TAP block was an effective postoperative analgesia method for patients undergoing laparoscopic cholecystectomy.

Keywords: Transversus abdominis plane block, TAP block, laparoscopic cholecystectomy

Introduction

Laparoscopic cholecystectomy is one of the most popular minimally invasive surgery, but it is still associated with postoperative pain of moderate intensity in the early postoperative period [1, 2]. Pain after laparoscopic cholecystectomy is reportedly complex, which has several origins: incisional, local visceral, peritoneal and referred. Abdominal wall incisional pain after laparoscopic cholecystectomy has been considered as a substantial component and the main reason for patients discomfort and longer hospital stay [3]. Opioids are the common and efficient analgesics, but are accompanied with the dose-dependent side effects such as nausea, vomiting and respiratory depression [4]. In recent years, TAP block may be a popular analgesia option that may provide up to 24 hours of analgesia for postoperative pain after laparoscopic cholecystectomy [5].

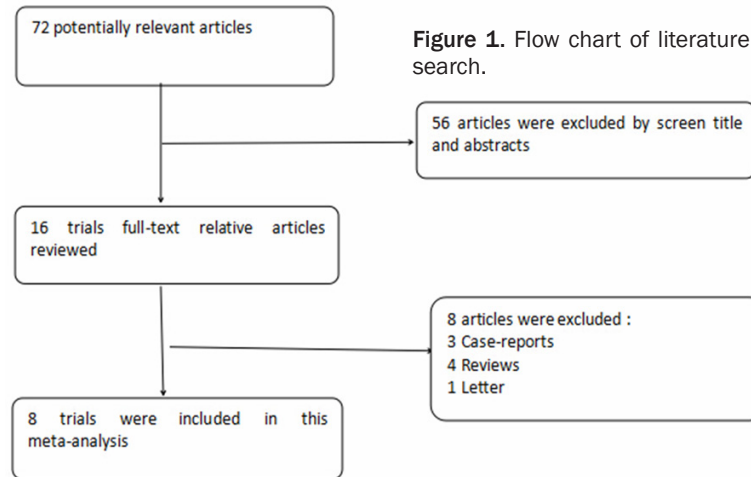
The transversus abdominis plane block is a regional anesthesia technique that involves

deposition of local anesthetic into the fascial plane superficial to the transversus abdominis muscle at the level of the T7-L1 dermatomes [6]. Although the extent of sensory blockade achieved by the TAP block has been debating, [7-10] ultrasound-guided TAP block has been used for providing pain relief following abdominal surgeries, and mainly for lower abdominal surgery [6, 11-17]. However, there has been no systematic review evaluating the efficacy of the TAP block compared with no TAP block or sham groups for pain after laparoscopic cholecystectomy. So we conduct this meta-analysis to assess the efficacy of TAP block in people undergoing elective laparoscopic cholecystectomy.

Materials and methods

We conducted and reported this systematic review and meta-analysis in consistent with the PRISMA guideline [18]. We searched MEDLINE (2001-2015), EMBASE (1968-2015) and other

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major medical databases for randomized controlled trials (RCTs) that assessed the efficacy of TAP block in people undergoing elective laparoscopic cholecystectomy and reported on postoperative pain intensity scores and/or opioids consumption. The key words are “Transversus abdominis plane block” or “TAP block” and “laparoscopic cholecystectomy”. The date of the last computer search was December 2015. In addition, references from relevant articles were searched for further studies, and the search was performed without limitations.

Study selection

Two reviewers selected articles meeting the inclusion criteria for potentially eligible RCTs separately. After screening the titles and abstracts, eligible papers were further retrieved for full-text. Trials included were followed the inclusion and exclusion criteria. Any discrepancies between the two reviews were resolved by discussion with the third reviewer.

Inclusion and exclusion criteria

The trials that met the following criteria are included: 1) Randomized controlled trials; 2) People under going laparoscopic cholecystectomy and have received TAP block; 3) Post-operative pain intensity scores at different time points during the first 24 hours should have been reported; 4) The postoperative opioids consumption should have reported. Exclusive were trials reporting administration without an active control group or not undergoing laparoscopic cholecystectomy.

Assessment of study quality

The quality of included articles were assessed independently by two reviewers using the risk of bias table suggested by the Cochrane Collaboration [19] evaluating selection bias (randomization sequence generation and allocation concealment), performance bias (blinding of participants and personnel), detection bias (blinding to outcome assessment), attrition bias (incomplete outcome data), and reporting bias (selective reporting).

For each parameter, studies were assessed as low, unclear, or high risk of bias. Any disagreements were resolved by discussion with the third reviewers.

Date extraction

Two reviewers designed a standardized data collection form and extracted data separately on: author’s name, publication year, journal, the interventions between TAP block group and control group, number of TAP group and control group, postoperative analgesic consumption, postoperative pain intensity scores at rest or on movement or both, adverse effects (nausea or vomiting).

The two reviewers extracted the data from the provided graph if the data were presented in a graph and the authors cannot be contacted. We would transfer medians and ranges to means and standard deviations [20]. The type of postoperative analgesics were different in trials, so we converted tramadol consumption to morphine equivalents using a conversion factor of 1:10 [21] and fentanyl consumption was converted to morphine equivalents using a conversion factor of 1:100 [22]. Pain scores reported as Visual, Numeric Rating Scales were converted to a standardized 0 to 10 analog scale for quantitative evaluations. If pain scores were not reported at rest or on moving, we considered it as at rest. Any disagreements were resolved by discussion with the third reviewer.

The primary outcomes were opioids consumption at 24 hours. Secondary outcomes were pain scores at 6 h and 24 h at rest, pain scores

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Table 1. Characteristics of included studies

Aurhor (Published Year)	Publication	Block Method	Intervention and the number of each group
Saliminia, A. (2015)	Acta Anaesth Taiwanica	Posterior TAP block	Placebo group (n = 18): TAP block with 0.9% NS 16 ml in each side; TAP group (n = 18): TAP block with 30 ml of B _{0.5} plus 2 ml NS, 16 ml in each side; TAP plus suf group (n = 18): TAP block with 30 ml of B _{0.5} plus 2 ml (10 ug) suf, 16 ml in each side
Elamin, G. (2015)	J Am Coll surg	Subcostal and Petit triangle TAP block	Control group (n = 40): TAP block with 50 ml NS and local infiltration with 20 ml B _{0.5} ; TAP group (n = 40): TAP block with 50 ml B _{0.25} and local infiltration with 20 ml NS
Basaran, B. (2015)	Med Sci Monit	Posterior TAP block/subcostal TAP block	Control group (n = 38): no TAP block; posterior TAP group (n = 20): TAP block with R _{0.375} 15 ml on each side; subcostal TAP group (n = 20): TAP block with R _{0.375} 15 ml on each side
Petersen, P. L. (2012)	Anesth Analg	Posterior TAP block	Placebo group (n = 37): TAP block with 0.9% NS 10 ml each side; TAP group (n = 37): TAP block with R _{0.5} 10 ml each side
Ortiz, J. (2012)	Reg Anesth	Posterior TAP block	Control group (n = 39): local infiltration with 20 ml R _{0.5} ; TAP group (n = 37): TAP block with R _{0.5} 15 ml each side
Ra, Yoon Suk (2010)	Korean J Anesthesiol	Petit triangle TAP block	Control group (n = 18): no TAP block; TAP B _{0.25} group (n = 18): TAP block with B _{0.25} 15 ml each side; TAP B _{0.5} group (n = 18): TAP block with B _{0.5} with 15 ml each side
El-Dawlatly, A. A (2009)	Br J Anaesth	Posterior TAP block	Control group (n = 21): no TAP block; TAP group (n = 21): TAP block with B _{0.5} 15 ml on each side

NS, normal saline; suf, sufentanil, TAP, transversus abdominis plane; B_{0.25}, 0.25% bupivacaine; B_{0.5}, 0.5% bupivacaine; R_{0.5}, 0.5% ropivacaine; R_{0.375}, 0.375% ropivacaine.

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Table 2. Outcome variables in randomized controlled trials

Author (Year)	At rest or on moving	Pain Scores, Mean ± SD							
		Control		TAP		Control		TAP	
		2 h		6 h		24 h			
Saliminia, A. (2015)	At rest	NR	NR	6.44±2.20	3.61±2.25/3.94±2.24	1.44±1.04	0.83±0.92/0.83±1.09		
Bhatia, N. (2014)	At rest	3±1.3	1.6±1.5/0.8±0.89	2±1.1	1.6±1.3/0.9±1.1	1.3±1.0	0.8±0.8/0.15±0.36		
	On moving	4.1±1.6	2.8±1.6/1.9±1.4	3.3±1.0	2.8±1.6/1.9±1.4	2.5±1.4	1.7±1.3/0.5±0.8		
Petersen, P. L. (2012)	At rest	3.69±1.93	3.1±1.75	2.13±1.32	1.87±1.5	1.6±1.59	1.5±1.24		
	On moving	5.14±2.35	2.86±2.03	3.5±1.85	2.61±1.93	2.53±2.03	2.42±1.55		
Ra, Yoon Suk (2010)	At rest	NR	NR	6.1±1.98	3.1±1.55/1.9±1.43	4.4±1.68	1.6±1.46/1.3±0.97		

TAP, transversus abdominis plane; NR, no reported; h, hours.



Figure 2. Methodological quality summary: review authors' judgements about each methodological quality item for each included studies.

at 6 h and 24 h on moving and the incidence of nausea or vomiting.

Statistical analysis

Analyses were performed using the Review Manager (RevMan) version 5.1 (RevMan 5.1, The Cochrane Collaboration, Oxford, United Kingdom). In the studies included in this meta-analysis, the continuous variables were calcu-

lated for mean difference (MD) and 95% confidence interval (95% CI). For dichotomous variable, we used the odds ratio (OR) and 95% CI. The heterogeneity among the included studies was evaluated using the I² statistic and P-value of Chi Squared test. If I²<50% or P > 0.1, a fixed effects model was used. Otherwise, we adopted the random effects model. All tests of statistical significance were two-sided [23]. We considered P<0.05 as statistical significant. Sensitivity analysis were carried out by deleting one study each time and explore the impact of an individual study on the overall pooled estimation. Publication bias was assessed by visually inspecting funnel plots if at least ten trials of each intervention were included. Forest plots were used to represent and evaluate the treatment effects.

Results

Results of the search and description of studies

We initially included 72 potentially relevant articles by search the major medical databases, 56 of which were excluded by screening the title and abstracts. We excluded 1 letter, 3 case-reports and 4 reviews among the remaining 16 articles. Finally, 8 full-text studies with a total of 496 patients (269 patients received TAP block and 227 patients served as controls) were included in this meta-analysis (**Figure 1**) [5, 6, 14, 24-28]. The characteristics of the 8 included studies are show in **Table 1**, which contained the authors, the published year, the intervention of experimental groups, the numbers of TAP block group and control group respectively, the block methods. The pain scores at different times postoperatively (at 2 h, 6 h, 24 h) are shown in **Table 2**. The majority trials had a low risk of bias as shown in **Figure**

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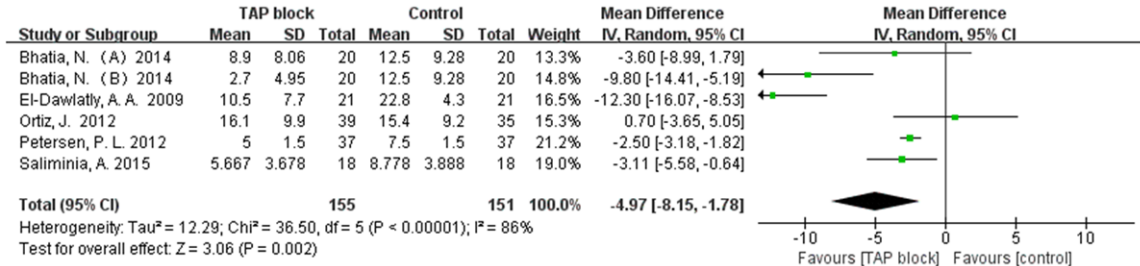


Figure 3. Postoperative analgesic consumption during 24 h with or without TAP block after laparoscopic cholecystectomy.

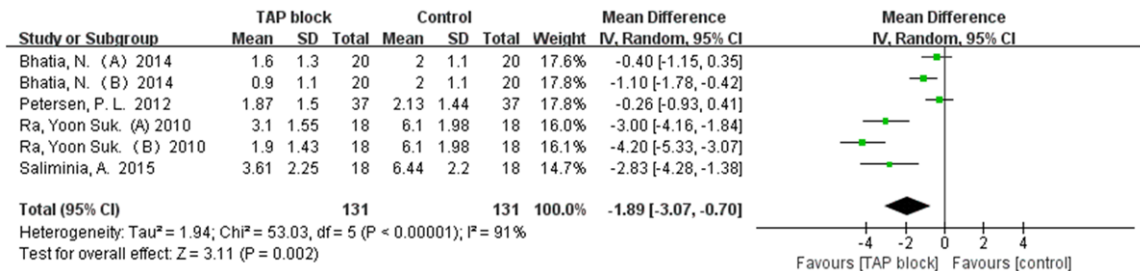


Figure 4. Pain intensity score at 6 h at rest with or without TAP block after laparoscopic cholecystectomy.

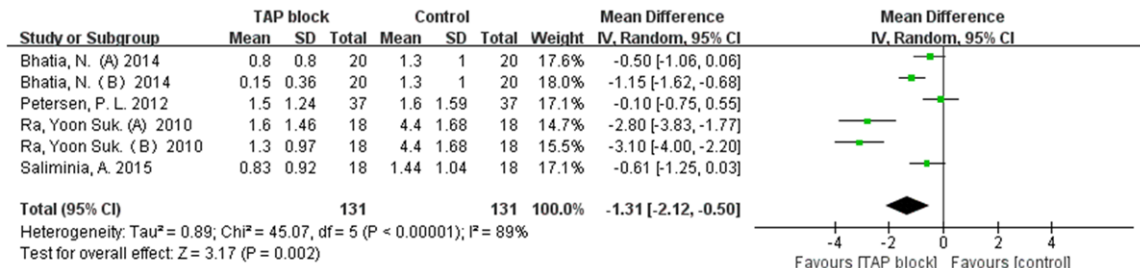


Figure 5. Pain intensity score at 24 h at rest with or without TAP block after laparoscopic cholecystectomy.

2 according to the Cochrane Collaboration Risk of Bias tool.

Primary outcome

Postoperative analgesic consumption during 24 h: Five studies [5, 14, 24, 25, 28] including 306 patients (155 TAP block group VS 151 control group) suggested a significant reduction in analgesic consumption in the TAP block groups (random effects model: MD = -4.97, 95% CI -8.15 to -1.78, P = 0.002) (Figure 3). The pooled results was significant (P = 0.002 < 0.05).

Secondary outcomes

Pain intensity score at 6 h at rest: Data on pain score at 6 h and 24 h at rest were available in 4

trials [5, 6, 25, 28] including 262 patients (131 TAP block group VS 131 control group). Pooled results showed a statistically significant reduction for pain intensity score at rest at 6 h with TAP block (random effects model: MD = -1.89, 95% CI -3.07 to -0.70, P = 0.002) (Figure 4). And at rest at 24 h (random effects model: MD = -1.31, 95% CI -2.12 to -0.50, p = 0.002) (Figure 5).

Pain intensity scores at 6 h and 24 h on moving: Pain scores at 6 h and 24 h on moving were investigated in two studies [5, 25] including 154 patients (77 TAP block group VS 77 control group). Pooled results showed that the reduction for pain intensity scores on moving at 6 h with TAP block were statistically significant

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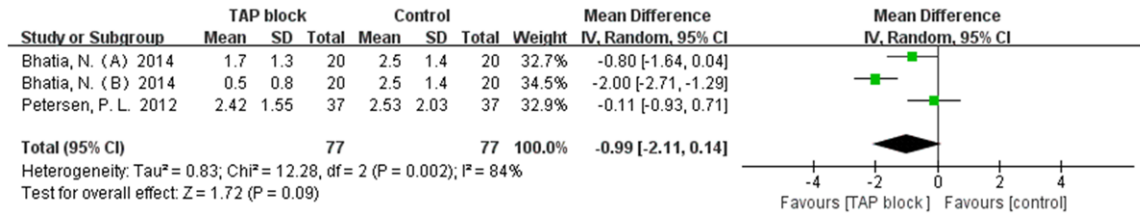


Figure 6. Pain intensity score at 6 h on moving with or without TAP block after laparoscopic cholecystectomy.

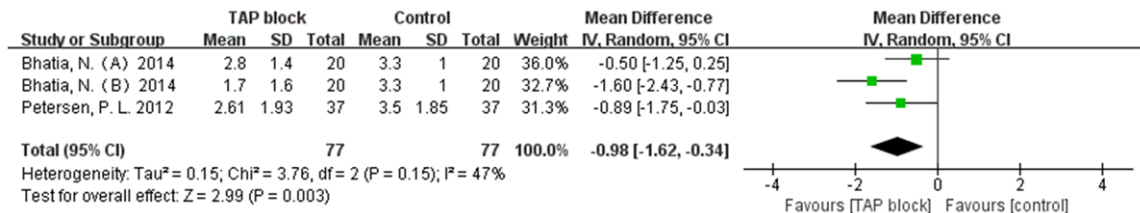


Figure 7. Pain intensity score at 24 h on moving with or without TAP block after laparoscopic cholecystectomy.

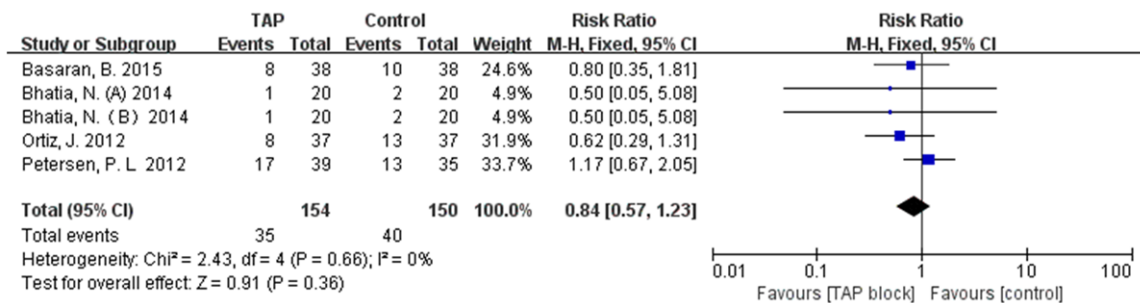


Figure 8. The incidence of vomiting or nausea with or without TAP block after laparoscopic cholecystectomy.

(random effects model: MD = -0.98, 95% CI -1.62 to -0.34, P = 0.003) (Figure 6) but not at 24 h with TAP block (random effects model: MD = -0.99, 95% CI -2.11 to 0.14, P = 0.09) (Figure 7).

The incidence of vomiting or nausea: There were 4 studies [5, 24-26] including 304 patients (154 TAP block group VS 150 control group) reporting the incidence of postoperative vomiting or nausea. There were no significant difference in postoperative vomiting or nausea (I² = 5%, P = 0.69) (Figure 8).

Discussion

We carried out this meta-analysis to evaluate the analgesia effect of the transversus abdominis plane block for postoperative pain after laparoscopic cholecystectomy compared with no transversus abdominis plane block or pla-

cebo group. Our results suggested that the total analgesic consumption within the first postoperative 24 hours were reduced significantly, and less VAS pain scores within 24 hours at movement and at rest compared with placebo groups. But it didn't reduce the incidence of nausea and vomiting.

TAP block is currently described as an effective technique for the management of pain after laparoscopic cholecystectomy. El-Dawlatly was the first to evaluate the postoperative analgesia efficacy in patients undergoing laparoscopic cholecystectomy under general anesthesia with or without TAP block [14]. In his studies, ultrasound-guided TAP block substantially reduced the perioperative analgesic consumption in patients undergoing laparoscopic cholecystectomy. Regrettably, neither pain scores nor side effects were reported. Ra, Yoon Suk [6], Petersen, P. L. [5], Bhatia, N [25], Salimonia,

A [28], Basaran, B [26] evaluated the efficacy of ultrasound-guided TAP block on pain after laparoscopic cholecystectomy, compared with normal saline injection or without TAP block. All of them found TAP block could reduce postoperative pain in patients undergoing laparoscopic cholecystectomy. But Petersen stated that TAP block had rather small effect in reducing pain while coughing postoperatively. Both Bhatia, N [25] and Basaran, B [26] reported a significant reduction in postoperative tramadol consumption within the first 24 hours in the TAP block group than control group.

Whether local anesthetic infiltration is equivalent to TAP blocks in present studies is controversial. In Ortiz, J's study [24], he and his colleagues investigated whether the bilateral ultrasound-guided TAP blocks can decrease pain after laparoscopic cholecystectomy or not when compared with local anesthetic infiltration of trocar insertion sites. They found that pain scores between treatment groups during the first 24 hours after laparoscopic cholecystectomy is equal. While in Elamin's report, [27] they confirmed the therapeutic benefit of laparoscopic-assisted 4-quadrant TAP block in laparoscopic cholecystectomy when compared with local anesthetic wound infiltration after the analysis of postoperative pain scores. The different outcomes may attribute to the different technique of TAP block and different volume of local anesthetics. In Elamin's studies, with the aid of direct visualization of peritoneum with the laparoscope, TAP block were instilled at 4 points as followed: bilateral subcostal infiltration between anterior axillary and mid clavicular lines (10 ml each), and bilateral infiltration at the triangle of Petit above the iliac crest at mid-axillary line (15 ml each). While Ortiz, J. conducted the transversus abdominis plane blocks under direct ultrasound visualization at the level of the bilateral anterior axillary line between the 12th rib and the iliac crest (15 ml each).

Our meta-analysis is limited by the small sample size with 496 patients included and the significant heterogeneity of the outcomes. In addition, the type and concentration of local analgesics are different, which will affect the efficacy of block. Finally, the method of TAP block was varied in different trials. Elamin, G. report-

ed the laparoscopic-assisted TAP block technique. Subcostal TAP was performed in Bhatia, N and Basaran, B's studies. While the other conducted the posterior or Petit triangle TAP block. Thus, different techniques of TAP block and local anesthetics may have an effect on the postoperative pain score.

In summary, TAP block can significantly decrease the postoperative analgesics and relieve the postoperative pain in patients received laparoscopic cholecystectomy. In addition, TAP block would not increase the incidence of vomiting or nausea.

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Disclosure of conflict of interest

None.

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