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The efficacy of transversus abdominis plane block for postoperative analgesia in laparoscopic cholecystectomy cases: a retrospective evaluation of 515 patients

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Abstract

Objective: To compare patients that received intravenous (i.v.) analgesics with those that received transversus abdominis plane (TAP) block for pain relief after laparoscopic cholecystectomy.

Methods: This retrospective study enrolled patients that had undergone laparoscopic cholecystectomy and divided them into two groups: the i.v. analgesic group (controls; group A) and the TAP block group (group T). Data retrieved from the medical records included postoperative visual analogue scale (VAS) pain scores, duration of intensive care unit (ICU) stay, total hospital stay, additional analgesic requirements and the occurrence of nausea and vomiting.

Results: A total of 515 patients were included (group A, $n = 247$; group T, $n = 268$). Postoperative VAS pain scores at 0, 2, 4 and 6 h and the need for additional analgesics were significantly lower in group T than in group A. Postoperative VAS pain scores at 12 and 24 h were significantly higher in group T than in group A. Postoperative nausea and vomiting were significantly lower in group T than in group A. The rate of ICU admission in group T was significantly lower than in group A.

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Conclusions: Effective postoperative analgesia can be achieved with TAP block and undesirable effects can be reduced.

Keywords
Analgesia, transversus abdominis plane block, visual analogue scale pain scores, postoperative nausea, postoperative vomiting

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Introduction

Laparoscopic cholecystectomy is one of the most common surgical operations and the length of hospital stay in the postoperative period is short.[1] Although there is less postoperative pain in laparoscopic cholecystectomy operations than in open cholecystectomy operations, moderate and severe pain are the most common problems, especially during the first 24 h.[2] Adequate control of pain is an important criterion for early and same-day hospital discharge. Multimodal analgesic approaches, such as intravenous patient-controlled analgesia and patient-controlled thoracic epidural analgesia are generally used for the treatment of pain.[3] A recently introduced regional nerve blockade procedure, transversus abdominis plane (TAP) block, is becoming a popular approach as part of a multimodal strategy to optimize postoperative pain control.[4] TAP block was first described in 2001 as a local anaesthetic injection into the Petit's triangle between the transversus abdominis and internal oblique muscles.[5] Ultrasonography-guided (USG) TAP block was used for the first time in 2007 and was reported to be more effective and safer than blind blockade methods.[6] TAP block has been shown to decrease intraoperative opioid use in laparotomy, appendectomy, caesarean section and laparoscopic cholecystectomy operations.[7] Conventional pain management with opioids increases the incidence of adverse effects, such as excessive sedation and postoperative nausea and vomiting (PONV).[8] Multimodal analgesia strategies involving different classes of analgesics or local anaesthetics may reduce both pain and postoperative adverse effects.[8]

The aim of the current study was to retrospectively compare the data from patients that underwent laparoscopic cholecystectomy with and without bilateral subcostal TAP block in terms of the occurrence of undesirable effects, such as high pain scores, additional intravenous (i.v.) analgesic requirements, longer intensive care unit (ICU) and total hospital stays, and the occurrence of nausea and vomiting.

Patients and methods

Study design and patient population

This retrospective study analysed data from consecutive patients that underwent laparoscopic cholecystectomies between March 2013 and May 2017 in the Department of General Surgery, Van Regional Training and Research Hospital, Van, Turkey. The sample size of the study was not calculated and the sample of the study consisted of the file information for those patients who were screened between the dates of the study. The inclusion criteria were as follows: (i) patients aged 18–75 years; (ii) a body mass index (BMI) $< 35\,kg/m^2$; (iii) an American Society of Anesthesiologists (ASA) physical status class I–II.

Patient data were retrieved from the medical records, which included observational records provided by nurses in the postanaesthesia care unit (PACU) and the general surgery service. The exclusion criteria were as follows: (i) emergency and haemorrhagic patients; (ii) patients with ASA class ≥III; (iii) pregnant women; (iv) morbidly obese patients with a BMI ≥35 kg/m^2; (v) patients with local anaesthetic allergy; (vi) patients receiving daily analgesic use for chronic illness; (vii) patients with previous abdominal surgery; (viii) patients with a history of coronary artery disease; (ix) patients with previous laparoscopic procedures; (x) patients that were converted to open surgery. Patients were divided into two groups: those that received bilateral subcostal TAP block after anaesthesia induction (group T); and those that received dual i.v. analgesic therapy as a control group (group A) 30 min before the end of the operation.

Ethical approval for this study was granted by the Health Sciences University Van Training and Research Hospital Human Research Ethics Committee (no. 2019/08). Written informed consent was obtained from all study participants.

Anaesthesia management

Routine laparoscopic cholecystectomies were performed with standard general anaesthesia at the Van Regional Training and Research Hospital. Standard anaesthesia induction was performed with 2.5 mg/kg propofol i.v. (propofol 1%; 1g/100 ml; Fresenius Medical Care, Bad Homburg, Germany), 2 µg/kg fentanyl i.v. (0.05 mg/ml fentanyl; 10 ml; Johnson & Johnson, New Brunswick, NJ, USA) and 0.6 mg/kg rocuronium bromide i.v. (Esmeron® 100 mg/10 ml; Merck & Co., Kenilworth, NJ, USA). Intubation tubes of sizes 7.0–7.5 for women and 8.0–8.5 for men were used. Maintenance was achieved with 2 MAC sevoflurane in a mixture of 50% oxygen +50% air.

For patients undergoing TAP block (group T), all block procedures were performed by the same experienced anaesthesiologists (A.E.T. & E.E.). The block area was cleaned with antiseptic. A high frequency linear ultrasound probe (M-Turbo® ultrasound system; FUJIFILM Sonosite Inc., Bothell, WA, USA) was placed in the transverse plane of the anterolateral abdominal wall on the midaxillary line between the lower costal margin and the left and right iliac crest (Petit's triangle). Subcutaneous adipose tissue, the external obligatory muscle, the internal obligatory muscle, the transverse abdominis muscle fascia and the peritoneum were seen with cephalic and caudal movements of the probe. A 20-gauge, 100-mm peripheral block needle was visually monitored near the plane until it reached the plane between the transversus abdominis muscles. The block needle was fixed in the area between the internal oblique and transverse abdominis muscle fasciae. The needle position was confirmed by a 3-ml saline injection to visualize the correct plane spread of the solution after aspiration. A volume of 20 ml 0.5% bupivacaine and 10 ml saline was injected bilaterally into this area; and the surgical procedure was initiated. A total volume of 30 ml was applied to each side: 10 ml saline +20 ml 0.5% bupivacaine.

For patients receiving i.v. analgesics (group A), surgical procedures were initiated by surgeons experienced in laparoscopy (M.K.B. & M.Ö.Ö.). Doses of 1 mg/kg tramadol i.v. and 20 mg/kg paracetamol i.v. were administered as a standard to patients in this group 30 min before extubation in coordination with the surgical team.

Study outcomes

After extubation, the time at which patients were admitted to the postoperative recovery

unit was designated as hour 0. Pain scores were determined using a visual analogue scale (VAS), which displays a line indicating a pain score (0 = no pain at one end, 10 = intolerable pain at the other end), were recorded at 0, 2, 4, 6, 8, 12, and 24 h. In case of additional analgesic requirements, 50 mg dexketoprofen trometamol i.v. was administered and the time of administration was recorded. In the postoperative period, nausea and vomiting were evaluated using a 3-point scale (0 = none, 1 = mild, 2 = severe). Patients with a nausea or vomiting score of 2 or those who could not tolerate their nausea received 10 mg metoclopramide hydrochloride orally once a day. Complications, ICU admission and total length of hospital stay were collected from medical records for both groups of patients.

Statistical analyses

All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY, USA). Continuous variables are presented as mean ± SD. Categorical variables are presented as *n* of patients (%). For normally distributed continuous variables, paired-group comparisons were undertaken using Student's *t*-test. For continuous variables that were not normally distributed, paired-group comparisons were undertaken using Mann–Whitney *U*-test. Categorical variables were compared using χ^2-test. A *P*-value <0.05 was considered statistically significant.

Results

A total of 515 patients met the inclusion criteria and had their data reviewed. Patients were divided into two groups: those that received bilateral subcostal TAP block after anaesthesia induction (group T; $n = 268$) and those that received dual i.v. analgesic therapy (group A; $n = 247$) 30 min before the end of the operation. The baseline demographic data for the two groups are presented in Table 1. There were no significant differences in terms of age, sex distribution and ASA status among the patients in the two groups.

In group T, the procedure was performed successfully on both sides of the abdomen and no complications related to the procedure (e.g. bruising, haematoma, oedema or infection at the injection sites) were observed. No local anaesthetic toxicities were reported. The duration of ICU stay and total hospital stay were significantly shorter in group T than in group A ($P < 0.05$ for both comparisons) (Table 2). There were no significant differences between the groups in terms of comorbidities and complication rates.

The PACU VAS scores and the VAS scores at 2, 4 and 6 h after the operation were significantly lower in group T than in group A ($P < 0.05$ for all comparisons)

Table 1. Baseline demographic data for patients ($n = 515$) enrolled in a retrospective study to compare laparoscopic cholecystectomy with and without bilateral subcostal transversus abdominis plane (TAP) block.

Characteristic	Group A $n = 247$	Group T $n = 268$
Age, years	45.95 ± 13.38	43.58 ± 13.26
Sex		
Female	197 (79.8)	203 (75.7)
Male	50 (20.2)	65 (24.3)
ASA status		
I	212 (85.8)	220 (82.1)
II	35 (14.2)	48 (17.9)

Data presented as mean ± SD or *n* of patients (%).
No significant between-group differences ($P > 0.05$); normally distributed continuous variables were compared using Student's *t*-test; continuous variables that were not normally distributed were compared using Mann–Whitney *U*-test; categorical variables were compared using χ^2-test.
ASA, American Society of Anesthesiologists.

Table 2. Clinical characteristics for patients ($n = 515$) enrolled in a retrospective study to compare laparoscopic cholecystectomy with and without bilateral subcostal transversus abdominis plane (TAP) block.

Characteristic	Group A $n = 247$	Group T $n = 268$	Statistical analysis[a]
VAS scores			
0 h (PACU)	3.02 ± 1.16	0.68 ± 1.01	$P = 0.001$
2 h	3.97 ± 2.10	0.91 ± 1.36	$P = 0.001$
4 h	3.72 ± 1.71	1.22 ± 1.68	$P = 0.001$
6 h	3.18 ± 1.05	2.28 ± 2.18	$P = 0.001$
12 h	2.61 ± 0.79	3.08 ± 1.83	$P = 0.001$
24 h	2.36 ± 0.68	2.66 ± 1.58	$P = 0.001$
Additional analgesic time, h	2.82 ± 1.38	1.51 ± 2.45	$P = 0.001$
ICU time, days	1.67 ± 0.82	1.59 ± 1.12	$P < 0.001$
Total hospital time, days	2.40 ± 1.40	1.80 ± 0.93	$P = 0.0011$
Analgesic requirement			
No	150 (60.7)	190 (70.9)	$P = 0.015$
Yes	97 (39.3)	78 (29.1)	
ICU admission			
No	218 (88.3)	262 (97.8)	$P = 0.001$
Yes	29 (11.7)	6 (2.2)	
Complications			
No	199 (80.6)	224 (83.6)	NS
Yes	48 (19.4)	44 (16.4)	
Comorbidities			
No	203 (82.2)	228 (85.1)	NS
Yes	44 (17.8)	40 (14.9)	
PONV			
No	168 (68.0)	222 (82.8)	$P = 0.001$
Yes	79 (32.0)	46 (17.2)	

Data presented as mean ± SD or *n* of patients (%).

[a]Normally distributed continuous variables were compared using Student's *t*-test; continuous variables that were not normally distributed were compared using Mann–Whitney *U*-test; categorical variables were compared using χ^2-test.

VAS, visual analogue scale; PACU, postanaesthesia care unit; ICU, intensive care unit; PONV; postoperative nausea and vomiting; NS, no significant between-group differences ($P > 0.05$).

(Table 2). The VAS scores in group T at 12 and 24 h after the operation were significantly higher than in group A ($P < 0.05$ for both comparisons).

The rate of additional analgesic use in group T was significantly lower than that in group A ($P < 0.05$) (Table 2). The rate of ICU admission in group T was significantly lower than that in group A ($P < 0.05$) (Table 2). A detailed evaluation could not be performed to determine whether this difference was due to the TAP block effect. The rate of PONV was significantly lower in group T than in group A ($P < 0.05$) (Table 2).

Discussion

Concomitant neuraxial and general anaesthesia may increase the effectiveness of perioperative pain management and may reduce the need for additional analgesics.[9,10] With the block procedure, patients who are less likely to perceive pain will be

more easily mobilized, breathe easier, have a lower risk of cardiac complications and ileus, and return to normal feeding more quickly than nonblocked patients.[1] In the present study, the effects of TAP block in patients undergoing laparoscopic cholecystectomy were compared with the effects of parenteral analgesia in patients without the block. Laparoscopic cholecystectomy was selected because it is performed frequently and can be performed in most hospitals. In addition, the effects of laparoscopic cholecystectomy on haemodynamic parameters are minimal and the prevalence of chronic pain is high.[11] After TAP block, especially in the first 6 hours, the current study found that the VAS pain score was significantly lower than with i.v. analgesics; the need for additional analgesics was decreased; and the rate of PONV decreased. Although ICU admission was lower and total hospital stay was significantly shorter in the patients that received TAP block compared with those that received i.v. analgesics, the available data were insufficient to correlate these effects with the block procedure.

Transversus abdominis plane block is a well-known pain relief technique that is used in patients after laparoscopic cholecystectomy. It involves the administration of a local anaesthetic to the plane between the internal obligatory and transversus abdominis muscles. It is a peripheral nerve block for the anterior abdominal wall afferent nerves (i.e. T6–L1). TAP block is often used after total abdominal hysterectomies, caesarean deliveries, open bowel surgeries and laparoscopic gall bladder surgeries.[12,13] A review of the published literature found that the effectiveness of the block before surgical incision was greater than after surgical incision.[14–18] Similarly, TAP block was performed before surgical incision in this current study. In contrast, a previous study that performed TAP block after the end of a surgical procedure found that there were no differences in terms of morphine consumption from the non-blocked group at 2 and 24 h post-operation.[19] Bupivacaine, levobupivacaine and ropivacaine are the most commonly used local anaesthetics for TAP block.[20] In addition to its low systemic toxicity, bupivacaine was preferred in the present study because of its strong anaesthetic properties.[21] Most studies have shown that TAP block reduces the need for analgesics 24 hours after cholecystectomy.[22,23] There is also evidence that this effect extends up to 48 hours.[24] Similarly in this current study, the pain scores at 0, 2, 4 and 6 h were significantly lower in the TAP block group than in the i. v. analgesic group. However, the 12- and 24-h pain scores were significantly higher in the TAP block group than in the i.v. analgesic group and higher than those in the literature.[25] In this current study, very low VAS pain scores were recorded for the first 6 h in TAP block patients (group T). The VAS pain scores were significantly higher in the i.v. analgesic group (group A) during the first 6 h. Therefore, the number of patients who needed additional analgesics was higher in group A. In our opinion, the 12- and 24-h VAS pain scores were relatively low in group A due to this additional analgesic.

If opioids are used for postoperative analgesia, unintended effects, such as prolonged hospital stay due to sedation, nausea, vomiting, bowel dysfunction and constipation, may occur.[26] A previous study evaluated the postoperative analgesic efficacy of TAP block and found that it decreased morphine consumption at 6, 12 and 24 h.[27] While the results of many publications parallel this study,[17,22,27] a meta-analysis of 12 articles including 650 patients found no association between the total bupivacaine dose and a decrease in morphine consumption at 6 h postoperatively.[28] Nonsteroidal anti-inflammatory drugs (NSAIDs) reduce opioid-related adverse

effects because they reduce opioid requirements, even if they insufficiently control postoperative pain as monotherapy.[29] Although the adverse effects of NSAIDs are rare, they may be serious and include nausea, vomiting, gastric tenderness, bleeding, anaphylaxis and acute renal failure, especially in the postoperative period.[30] Advanced age and long-term use increase these risks.[30] In the current study, the NSAID dexketoprofen trometamol was the preferred additional analgesic if required; the requirement of these additional medications was reduced in the TAP block group and complications related to NSAIDs were avoided.

Transversus abdominis plane block can be performed by sensing the loss of resistance in the Petit's triangle by the determination of anatomical points or by visual progression with USG. These classical anatomical points were previously identified, then the location of the needle tip was confirmed using USG, which facilitated the performance of bilateral TAP blockade.[31] However, in this previous study, the block procedure was stopped due to penetration into the peritoneal cavity at a high and unacceptable rate of 18%.[31] In addition, in 58% of the cases, the needle tip was located subcutaneously or intramuscularly.[31] In this current study, after determining the anatomical points with USG (which is easy, non-invasive, and quick with a rapid onset and low potential of lower intra-abdominal organ damage), TAP block was performed and adverse effects were not observed. Another study compared the lateral TAP block with the USG-guided TAP block after caesarean operations in 76 patients.[32] In accordance with the current results, this previous study emphasized the pain relieving superiority of TAP block with USG for all time periods.[32]

In conclusion, this present study demonstrated that the TAP block method would provide effective postoperative analgesia in patients undergoing laparoscopic cholecystectomy, reduce the rate of adverse effects, such as nausea and vomiting, and reduce the need for additional analgesics, thus possibly reducing the rate of analgesic-related adverse effects. Although the need for ICU and total hospital stay were significantly shorter in the TAP block group and there were no significant differences between the groups in terms of comorbid diseases and complications, larger comparative studies are needed to provide increased statistical power.

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Author contributions

A.E.T. planned the study and organized the team, prepared the ethics applications, helped collect the data, managed the anaesthesia and performed the TAP block; E.E. assisted with the TAP block and the anaesthesia management; M.K.B. undertook the laparoscopic cholecystectomy operations with other surgeons and helped to collect the data in the general surgery service; M.Ö.Ö. assisted with the laparoscopic cholecystectomy operations and collected data in the PACU.

Declaration of conflicting interest

The authors declare that there are no conflicts of interest.

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