Original Article

Efficacy of the subcostal transversus abdominis plane block in laparoscopic cholecystectomy: Comparison with conventional port-site infiltration

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Abstract

Background: Pain experienced following laparoscopic cholecystectomy is largely contributed by the anterior abdominal wall incisions. This study investigated whether subcostal transversus abdominis (STA) block was superior to traditional port-site infiltration of local anesthetic in reducing postoperative pain, opioid consumption, and time for recovery.
Materials and Methods: Forty-three patients presenting for day case laparoscopic cholecystectomy were randomly allocated to receive either an ultrasound-guided STA block ($n = 21$) or port-site infiltration of local anesthetic ($n = 22$). Visual analog pain scores were measured at 1 and 4 h postoperatively to assess pain severity, and opioid requirement was measured in recovery and up to 8 h postoperatively. The time to discharge from recovery was recorded.
Results: STA block resulted in a significant reduction in serial visual pain analog score values and significantly reduced the fentanyl requirement in recovery by >35% compared to the group that received local port-site infiltration (median 0.9 vs. 1.5 μcg/kg). Furthermore, STA block was associated with nearly a 50% reduction in overall 8-h equivalent morphine consumption (median 10 mg vs. 19 mg). In addition, STA block significantly reduced median time to discharge from recovery from 110 to 65 min.
Conclusion: The results suggest that STA block provides superior postoperative analgesia and reduces opioid requirement following laparoscopic cholecystectomy. It may also improve theater efficiency by reducing time to discharge from the recovery unit.

Key words: Subcostal block, laparoscopic cholecystectomy, analgesia, regional anaesthesia

Introduction

Laparoscopic cholecystectomy is a common minimally invasive procedure which is increasingly performed in the day case unit.[1] Pain experienced following laparoscopic cholecystectomy derives significantly from the incisions made in the anterior abdominal wall[2] which has segmental innervation provided by nociceptor afferents in the transversus abdominis fascial plane[3] between the internal oblique and transversus abdominis muscles. Although neuroaxial blockade and intraperitoneal lavage of local anesthetic[4-6] have been used successfully to reduce opioid use and improve postoperative analgesia, the operation is usually performed under general anesthesia with port-site infiltration of local anesthetic and supplementary opioid analgesia.

Recently, the uses of peripheral axial blocks that deliver local anesthetic into the transversus abdominis fascial plane have become popular for operations that involve incision(s) of the abdominal wall. Thus, the transversus abdominis plane (TAP) block has been shown to reduce perioperative opioid use in elective abdominal surgery,[7] including open appendicectomy,[8] laparotomy,[9] cesarean section,[10] and laparoscopic cholecystectomy.[6] However, the efficacy of the TAP block is reportedly only reliable in providing analgesia below the umbilicus.[11,12] In the one study[6] in which it was used for postoperative analgesia following laparoscopic cholecystectomy, the port sites were moved to facilitate the regional distribution of the block.

The ultrasound-guided subcostal transversus abdominis (STA) block is a recently described variation on the TAP

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block which produces reliable unilateral supraumbilical analgesia.[12] The present study was designed to evaluate the analgesic efficacy of STA block in reducing postoperative pain, opioid consumption, and recovery time following elective laparoscopic cholecystectomy.

Materials and Methods

The study was sponsored by the hospital trust and approved by the local research ethics committee. Written informed consent was gained from 43 ASA I/II adult (>16 years old) patients listed for elective laparoscopic cholecystectomy; patient characteristics and details of anesthesia and surgery are summarized in Table 1. Emergency patients were excluded as were those with allergy to local anesthetic agents, skin conditions precluding the block, or preoperative chronic dependence upon opioid medication. Based upon these exclusion criteria, only one patient was not eligible for the study.

Patients were blinded to the treatment group, as was the anesthetist involved in postoperative data collection. A standardized general anesthetic regime was employed, consisting of propofol (2.5 mg/kg), fentanyl (3 mcg/kg), and atracurium (0.6 mg/kg), with intraoperative non-opioid analgesia of paracetamol (15–20 mg/kg) and diclofenac (0.5 mg/kg) [Table 1]. A sealed envelope randomization system was employed to allocate patients to receive either an STA block (n = 21) or local anesthetic infiltration of the laparoscopy port sites (n = 22) using a standardized dose of 1 mg/kg bupivacaine hydrochloride (Marcain, Astra Zeneca UK) using sterile technique. Three subcostal and one periumbilical port sites were employed in all cases. The volume and dose of local anesthetic did not differ between the groups [Table 1]. The STA block was performed by one of two anesthetists with expertise in ultrasound-guided axial blocks, whereas port-site infiltration was performed by the surgeon. The block was performed under ultrasound guidance (Sonosite iLook, Sonosite Inc., Bothwell, UT, USA). The probe was placed in the midline of the abdomen 2 cm below the xiphisternum and moved right laterally along the subcostal margin to the anterior axillary line. The transversus abdominis muscle was identified lying beneath and extending lateral to the rectus abdominis muscle. A 100-mm, 22-G Stimuplex block needle was then guided, in plane, to a point just inferior to the right costal margin at the anterior axillary line such that the tip lay between the transversus abdominis and internal oblique muscle within the neurovascular fascial plane. Following aspiration, 1 mg/kg bupivacaine was deposited within the plane. Port-site infiltration was performed postoperatively in the usual manner using the same quantities and the dose of local anesthetic was divided equally between port sites [Table 1].

Postoperatively, patients were transferred to the recovery unit. Recovery nurses, who were blinded to the group intervention, were however told that the patients had received local anesthetic for patient safety purposes. In the recovery unit, patients received intravenous fentanyl analgesia in 20 mcg boluses. Administration of a bolus of fentanyl was triggered by pain described as moderate or severe when asked about their pain intensity on a scale of mild, moderate, or severe. The criteria for discharge from the recovery unit were pain control (absent or mild pain), absence of nausea and vomiting, hemodynamic stability, and alert or appropriately responsive to voice. On discharge, all patients had achieved a modified Aldrete score of ≥9.[13] Following discharge from the recovery unit, the patients were transferred to the day case ward where their analgesic requirements were satisfied on request with oral weak opioids and non-opioid analgesia. In the ward, analgesia requirement was checked at 20-min intervals and moderate to severe pain was treated.

Outcome data were collected by a third anesthetist who was blind to the treatment group of individual patients. The quality of analgesia was determined by comparing visual pain analog scores (VPAS) preoperatively and at 1 and 4h postoperatively. Opioid requirement was examined in a number of ways: the dose of fentanyl (mcg/kg) required in the recovery unit, individual postoperative analgesic requirement on the day case ward, and the overall 8-h equivalent morphine dose which was calculated as the morphine dose equivalent

Table 1: Patient characteristics, standardized doses (mean ± SEM) of anesthesia and analgesia, and dose and volume (mean ± SEM) of local anesthesia in the port-site infiltration (n = 22) and STA block (n = 21) groups

	Port-site infiltration	Subcostal block	Mann–Whitney U *P* value
Demographic			
Age (years)	48 ± 3	52 ± 3	0.78
Gender (M:F)	2:0	5:16	0.24[1]
BMI	28 ± 2	30 ± 2	0.3
Weight (kg)	76 ± 4	82 ± 5	0.18
Standard anesthesia/ analgesia			
Propofol (mg/kg)	2.4 ± 0.2	2.2 ± 0.2	0.56
Fentanyl (μg/kg)	3.1 ± 0.2	3.0 ± 0.2	0.85
Atracurium (mg/kg)	0.7 ± 0.04	0.65 ± 0.04	0.18
Paracetamol (mg/kg)	21 ± 2	16 ± 1.5	0.61
Diclofenac (mg/kg)	0.65 ± 0.1	0.58 ± 0.1	0.5
Procedural times (min)			
Induction of anesthesia	12 ± 1	16 ± 2	0.38
Operation time	76 ± 5	68 ± 5	0.72
Local anesthetic			
Dose (mg/kg)	1.2 ± 0.1	1.1 ± 0.1	0.34
Volume (ml)	21 ± 1	22 ± 1	0.85

to the opioid analgesia consumed (using opioid:morphine equivalents of 100 mcg i.v. fentanyl to 7 mg i.v. morphine; 60 mg oral codeine to 6 mg i.v. morphine; 100 mg oral tramadol to 10 mg i.v. morphine).[14] These outcome measures were chosen to reflect common practice of employing opioid analgesia of varying strengths as dictated by the WHO analgesia ladder[a]. In order to improve the accuracy of data concerning recovery time, the time recorded was the difference between admission time and the time the criteria for discharge were achieved (see methods).

Statistical analysis was performed using SPSS software. The Shapiro–Wilk test was employed to determine whether data sets differed from a normal distribution. Normally distributed data was analyzed using a repeat-measures general linear model analysis of variance (ANOVA), whereas non-normally distributed data were analyzed using the Mann–Whitney U-test and the Chi-squared test. The sample size of 21 per group was calculated assuming a 30% reduction in opioid use to provide 90% power at a significance level of 5%. The 30% assumed reduction was a conservative estimate based upon prior studies which show 45–70% reductions in postoperative morphine requirement following TAP blockade.[6-11]

Results

Patient data and details of the anesthesia and local anesthesia administered to each study group are shown in Table 1. No statistical differences were found in the parameters presented for each group in Table 1 (NS, Mann–Whitney U-test).

VPAS measurements were performed in order to assess the quality of analgesia achieved in the study groups. Statistical comparison showed that STA block was associated with lower postoperative pain scores ($P < 0.01$, ANOVA) [Figure 1]. Lower pain scores were accompanied by lower analgesic requirement in the STA group. In the recovery unit, the number of patients in each group who required fentanyl analgesia was not significantly different [Table 2]. However, patients who received the STA block required significantly less fentanyl analgesia than those who received local port-site infiltration (median 0.9 vs. 1.5 mcg/kg, $P < 0.05$, Mann–Whitney U-test) [Figure 2a]. Following discharge from the recovery unit to the day case ward, there were no differences between the groups in the requirements for morphine, tramadol, or non-opioid analgesic medication. Two patients (one from each group) could not be satisfied by oral analgesics and they received intramuscular morphine for breakthrough pain. However, overall, the 8-h equivalent morphine dose in the patients who received an STA block was significantly less than in those who received port-site infiltration of local anaesthetic (median 9.2 mg vs. 16.8 mg, $P < 0.01$, Mann–Whitney U-test) [Figure 2b]. Significantly fewer patients in the STA group received codeine phosphate postoperatively ($P < 0.01$, Chi-squared test) and the amount of codeine required in this group was significantly less ($P < 0.01$, independent *t*-test) [Table 2].

In addition to a reduction in postoperative pain and analgesic requirement, STA block was also associated with reduced recovery time [Figure 3]. Median time to discharge from recovery in patients who received an STA block was 65 min compared with 110 min in the group that received port-site infiltration ($P < 0.005$, Mann–Whitney U-test). The reduction in recovery discharge time was not offset by increased anesthetic and operative times, which did not significantly differ between the treatment groups [Table 1].

Discussion

Good postoperative analgesia is an important component of adequate perioperative care. It is associated with improved outcome, a reduction in perioperative stress, improved patient satisfaction, and coupled with a reduction in opioid consumption, fewer adverse side effects.[15,16] The present study suggests that STA block reduces pain, opioid consumption, and recovery time following elective laparoscopic cholecystectomy.

To our knowledge, this is the first report of the efficacy of STA block in elective laparoscopic cholecystectomy surgery and, whilst the data suggest a significant benefit of the procedure compared to conventional port-site infiltration with local anesthetic, the study has a number of limitations. The extent of the block in each group was not tested. The anesthetists

a WHO Analgesia Ladder available at http://www.who.int/cancer/palliative/painladder/en/. Last accessed on 02/12/11.

Table 2: Opioid analgesic requirement (±SEM) in the 8-h post-laparoscopic cholecystectomy in patients who received either STA block or port-site infiltration of local anesthetic (LA)

Opioid drug (mg)	Proportion receiving drug		Chi-squared	Mean (±SEM) 8-hourly requirement (mg/kg)		Independent *t*-test
	LA	STA		LA	STA	
Morphine	3/22	1/21	$P = 0.61$	3 ± 0.03	1 ± 0.9	$P = 0.3$
Tramadol	8/22	6/21	$P = 0.75$	0.54 ± 0.21	0.27 ± 0.1	$P = 0.27$
Codeine	15/22	5/21	$P < 0.01$	0.77 ± 0.16	0.22 ± 0.1	$P < 0.01$

STA: Subcostal transversus abdominis, LA: Local anesthetic

and surgeons administering local anesthetic were not blind to the treatment; however, neither group was involved in subsequent data collection. The study is also limited in that data were collected only up until 8 h postoperatively as it was envisaged at the outset that day case patients would be discharged by this point. It is also noteworthy that the post-incisional port-site infiltration was employed in this study. Pre-incisional infiltration is also a recognized analgesic technique for laparoscopic cholecystectomy; however, its efficacy compared with STA block has not been investigated and may be superior.

The demonstrated analgesic efficacy of STA block in elective laparoscopic cholecystectomy is consistent with prior studies that demonstrate reduction in opioid analgesic requirement and reduced pain scores following TAP block in appendicectomy, cesarean section, and laparoscopic cholecystectomy.[5-11] It was reported previously that the TAP block results in similar reductions in opioid use;[6] however, this study necessitated adjustment of the port-site positions to facilitate the anatomical distribution of the block[11,12] and postoperative analgesia was limited to sufentanil. In contrast to this and other studies, [6-11] the outcome measures in the present study were considered to better reflect current postoperative analgesia practice where a range of non-opioid, weak, and strong opioid analgesics are employed, as per WHO analgesic ladder[a]. STA block significantly reduced intravenous fentanyl requirement in the recovery unit and the overall equivalent morphine dose postoperatively. There were no differences between groups in either non-opioid analgesic dose or the doses of anesthetic agent that might have contributed to postoperative analgesia in these patient groups.

The improved quality of the postoperative analgesia associated with STA block further supports a growing body of evidence that TAP block is superior to traditional infiltration techniques.[6-12] This study also showed the additional benefit of a reduced recovery time in patients who received STA blocks whilst not impacting significantly on anesthetic or operation duration.

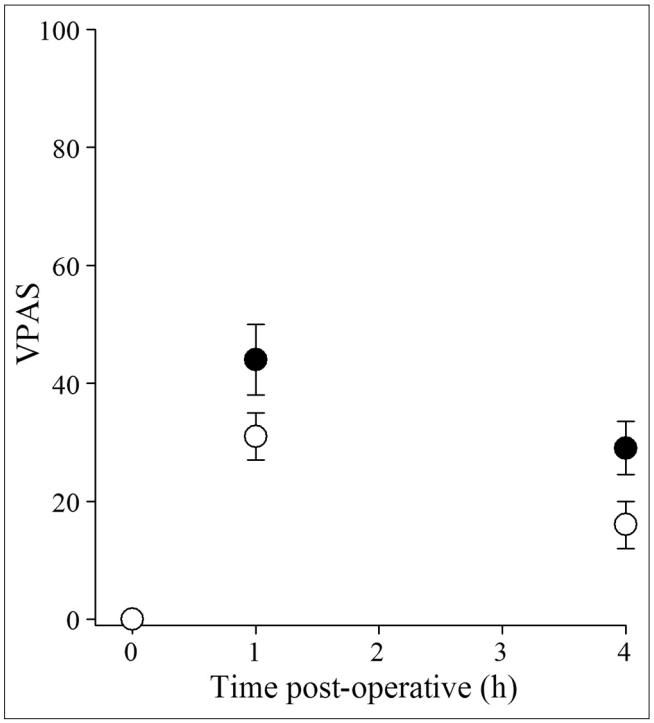

Figure 1: STA block (open circles) significantly reduced serial VPAS (mean ± SEM) following laparoscopic cholecystectomy compared with patients who received local port-site infiltration (filled circles; $P < 0.01$, ANOVA)

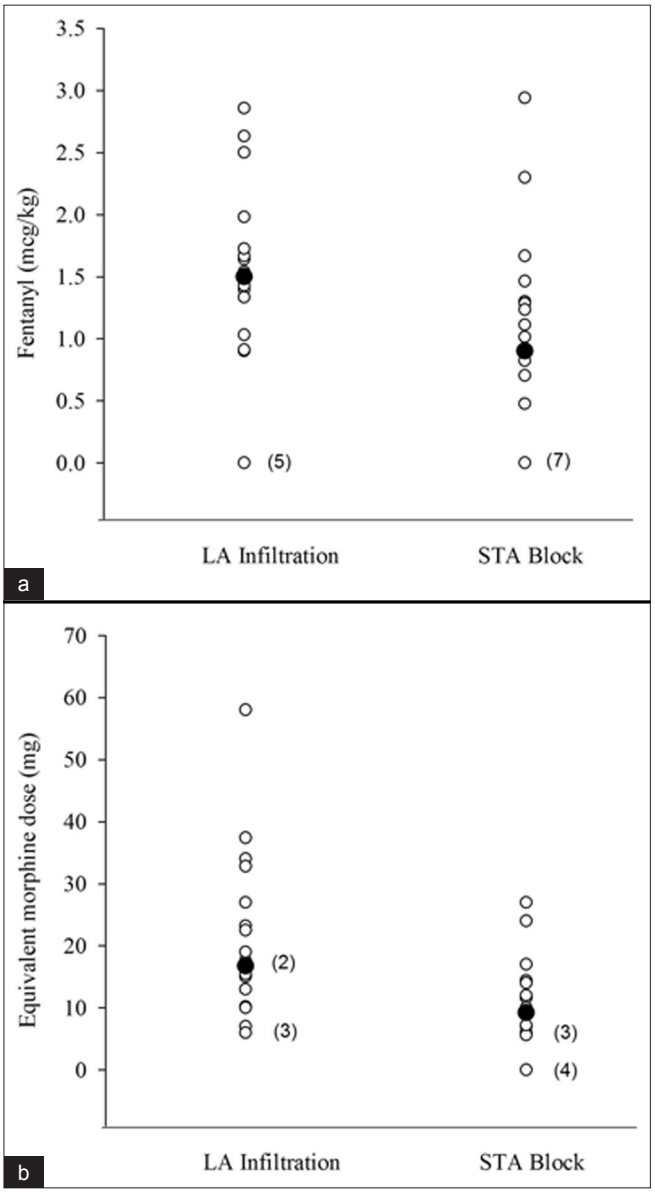

Figure 2: (a) The distribution of fentanyl doses (open circles) in patients who received STA block ($n = 21$) or port-site infiltration of local anesthetic ($n = 22$). (b) The distribution of equivalent morphine doses (open circles) in patients who received STA block ($n = 21$) or port-site infiltration of local anesthetic ($n = 22$) (Median doses shown as filled circles. The n values in parentheses indicate the number of patients with the same values in a particular group.)

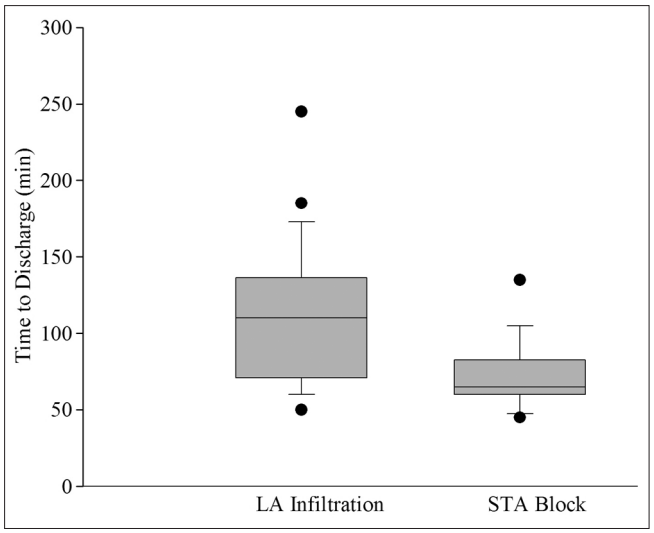

Figure 3: STA block reduces median time to discharge from the recovery unit following laparoscopic cholecystectomy compared with patients who received local port-site infiltration (***$P < 0.005$, Mann–Whitney U-test). The central box covers the interquartile range enclosing a line representing the median. The whiskers extend to the 10th and 90th percentiles and extreme values are plotted separately (filled circles)

This effect on efficiency is a significant finding, in particular, in hospitals such as ours, where recovery units have limited bed spaces and that are likely to see greater numbers of day case laparoscopic cases in future.[1]

Finally, it is noteworthy that there were no complications of STA block in the present study; however, the study was not powered to investigate this. All blocks were performed under ultrasound guidance which has the advantage of visualization of needle position in relation to the transversus neurovascular plane and real-time image of the site at which local anesthetic is deposited. In this regard, the study is in keeping with the growing body of opinion that ultrasonic guidance may be safer in the conduction of neural blockade.[17]

In summary, the present study provides further evidence that STA block can produce effective analgesia for upper abdominal laparoscopic surgery.[6-11] Furthermore, it effectively reduces opioid analgesic requirement in elective laparoscopic cholecystectomy and reduces the burden of these patients on recovery services. It is noteworthy that these effects were achieved with basic ultrasound devices, unilateral blocks, and single injection STA blocks. The use of bilateral blocks, multiple injection sites, or implanted catheters may further improve on the present findings.[11,18] Future studies to evaluate the analgesic efficacy and recovery benefits of axial blocks for all abdominal laparoscopic techniques would also be of interest.

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