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Original Research Article

Assessment of Postoperative Analgesia Using Ultrasound-Guided Transversus Abdominis Plane Block versus Intravenous Analgesia in Abdominal Surgery: A Randomized Clinical Trial

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Abstract

Background: When postoperative pain management is primarily systemic opioids, breathing exercises, mobilization and recovery are delayed by abdominal surgery.

Aim: This study aimed to compare ultrasound-guided transversus abdominis plane block (TAP block) with standard intravenous (IV) analgesia for postoperative analgesia after elective abdominal surgery.

Methods: ASA I-II adult patients undergoing abdominal surgery were randomized to either bilateral ultrasound guided TAP block (0.25% bupivacaine) or to receive intravenous analgesia alone (n=40). Paracetamol and rescue tramadol was administered to all patients. VAS scores, rescue analgesia, tramadol use, PONV, satisfaction and complications were noted.

Conclusions: VAS scores were significantly decreased at 2, 6 and 12 hours following TAP block. Time to first rescue analgesia was longer (8.6 +/- 3.1 versus 3.4 +/- 1.5 hours, p<0.001), and 24-hour tramadol consumption was lower (82.5 +/- 37.8 versus 168.0 +/- 55.4 mg, p<0.001). There were fewer patients needing two or more rescue doses (65.0% versus 22.5%, p<0.001). PONV was lower with TAP block (10.0% versus 27.5%, p=0.045). There were no complications associated with the block.

Conclusion: Ultrasound guided TAP block provided better early postoperative analgesia with decreased opioid use than IV analgesia alone.

Keywords: Transversus abdominis plane block, ultrasound guidance, abdominal surgery, postoperative analgesia, opioid sparing, and randomized trial.

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Introduction

It is important to have adequate postoperative pain control following abdominal surgery, in order to promote deep breathing and coughing, and to ensure patient satisfaction [1]. Opioids are still used systemically but have side effects such as nausea, vomiting, sedation, ileus and respiratory depression [2]. The goal of multimodal analgesia is to minimize the amount of opioids used by combining systemic and regional (local) anesthesia.

Transversus Abdominis plane block blocks thoracolumbar nerves between internal oblique and transversus abdominis [3] Using ultrasound guidance, the layers of the muscles are better visualized, the tip of the needle can be better seen and the amount of local anesthetic is better seen, so that the procedure is more reliable than blind landmark techniques [4]. TAP block has been applied to cesarean delivery, hernia repair and colorectal surgery, and laparoscopy surgery [5]. Benefit is supported by meta-analyses showing an opioid-sparing effect of TAP block, but these studies indicate that benefit depends on the surgical site, the approach used for block and the volume of local anesthetic and background analgesia administered [6,7]. Even in many centers, postoperative abdominal pain is still managed primarily by intravenously administered analgesics. A randomized comparison in a practical setting could help to elucidate the utility of TAP block in routine care.

Postoperative pain is significantly due to the abdomen wall. Inability to cope with somatic pain may affect breathing exercises and position changes. Intravenous opioids are effective, but can

be associated with nausea and sedation, especially in elderly patients, obese patients, or patients who are prone to vomiting [8]. Fascial plane blocks are appealing because they are easier to perform than neuraxial analgesia and do not provide sympathetic blockade. TAP block is not an effective treatment to abate visceral pain but can alleviate abdominal wall pain and decrease systemic analgesic consumption [9].

In the present trial, a bilateral TAP block performed under ultrasound guidance has been compared with intravenous analgesia in elective abdominal surgery. Primary outcome was 24-hour use of tramadol. Secondary outcomes included in the study were pain scores, timing of rescue analgesia, adverse events and patient satisfaction [10].

Materials and Methods

This is a randomized clinical trial that was conducted. Included were adults (18-65 years) ASA I-II who were undergoing elective abdominal surgery (lower or midline) under general anesthesia. Note that patients with injection site infection, chronic opioid use, severe hepatic and renal disease, BMI > 35 kg/m2, local anaesthetic allergy, and pregnancy were excluded.

Patients were randomly allocated to TAP group or IV group. Fentanyl, propofol, vecuronium and sevoflurane were employed as a standard protocol of general anesthesia. Patients in the TAP group were administered 0.25% bupivacaine (20 ml bilaterally) for bilateral ultrasound guided lateral TAP block at the end of surgery before emergence. The IV group did not get any block.

In the TAP group, the probe was placed transversely in the mid-axillary line between costal margin and iliac crest. External oblique, internal oblique and transversus abdominis muscles were located. A 22G echogenic needle was guided in plane and then hydrodissection was performed to ensure placement in the correct plane prior to the injection of local anesthetic.

Intravenous Paracetamol 1 g every 8 hours was given to all patients. Analgesia for rescue was tramadol 50 mg i/v when VAS score was 4 or above or requested by the patient and a maximum of 300 mg in 24 hours. Nausea/vomiting was treated with ondansetron.

At one, two, six, 12 and 24 hours an observer blinded to the group allocation assessed pain at rest and on movement. The main outcome was 24 h tramadol use. Secondary outcomes consisted of VAS scores, time to rescue analgesia, PONV, sedation, satisfaction and complications related to the block. Patient identifiers were not used, and coded study numbers were used to ensure confidentiality. Operations were carried out in accordance with normal standards for perioperative monitoring practice and no treatment was not administered which could be deemed necessary for patient safety.

Sample size was determined to give sufficient power for the primary outcome and was chosen to be feasible for a single-center, prospective study. All variables were checked for distribution prior to comparison. The results were presented as mean ± SD for normally distributed data, median (IQR) for the non-normally distributed data and number (%), for categorical data.

The definition of all adverse events was predetermined and was the same throughout the data collection. Rescue treatment was performed based on institutional procedures, not on the investigator's preference. All analyses were two-sided and a p value < 0.05 was deemed statistically significant.

The block was performed after the surgical procedure and before emergence to ensure patient comfort and prevent the emergence in a controlled sterile environment. The block was also performed at the end of surgery, ensuring that the analgesic effect measured was in keeping with the early postoperative period. The same local anesthetic concentration and volume were used in all TAP patients.

The postoperative pain management plan was documented in the chart and shared with the nurses. Rescue tramadol was only administered when the VAS threshold was met or when the patient requested it. This decreased the amount of variation in opioid doses and allowed for 24-hour opioid use to be a clinically relevant measure.

Patients were observed for local anesthetic systemic toxicity (LASST) symptoms such as perioral numbness, tinnitus, metallic taste, agitation, seizure and arrhythmia. Institutional safety policy provided emergency lipid emulsion in operating room.

Results

Eighty patients completed the study. Demographic characteristics, ASA status, type of surgery and duration of surgery were comparable between groups. No patient had failed block, local anesthetic toxicity or procedure-related hematoma.

Pain scores at rest and on movement were significantly lower in the TAP group at 2, 6 and 12 hours. At 24 hours, scores remained lower but the difference was smaller. This pattern was consistent with regression of a single-shot local anesthetic block.

Mean time to first rescue analgesia was significantly prolonged in the TAP group. Total 24-hour tramadol consumption was reduced by approximately half compared with intravenous analgesia alone. Only 9 patients in the TAP group required two or more rescue doses compared with 26 patients in the IV group. PONV was less frequent in the TAP group, probably because of reduced opioid exposure. Patient satisfaction scores were higher. Sedation scores were low in both groups, and no respiratory depression occurred.

Block performance added approximately 8-10 minutes to anesthetic time but did not delay extubation or recovery room transfer. No signs of bowel puncture, peritoneal injection, infection or systemic local anesthetic toxicity were observed. Movement-related pain showed the same overall pattern as pain at rest. Patients in the IV group reported more discomfort during coughing, turning and sitting up during the first 12 hours. This difference was important because dynamic pain can limit respiratory effort and early mobilization even when resting pain appears acceptable. The TAP group had higher satisfaction scores at 24 hours. Patients commonly reported that pain was tolerable during the first postoperative evening. In contrast, patients in the IV group more often requested rescue analgesia before the scheduled paracetamol dose.

No patient in either group required escalation to patient-controlled morphine or epidural analgesia. There were no signs of abdominal wall infection or delayed hematoma at the injection site. Hemodynamic variables in the recovery area were comparable between groups.

Table 1: Baseline characteristics

Variable	TAP group (n=40)	IV group (n=40)	p-value
Age (years)	43.8 +/- 12.4	45.1 +/- 11.7	0.63
Male/Female	21/19	20/20	0.82
BMI (kg/m2)	25.3 +/- 3.7	25.7 +/- 3.9	0.64
ASA I/II	24/16	22/18	0.65
Duration of surgery (min)	86.2 +/- 24.5	88.4 +/- 25.1	0.69

Table 2: Postoperative VAS scores at rest

Time point	TAP group	IV group	p-value
1 h	2.6 +/- 0.9	3.4 +/- 1.1	0.001
2 h	2.8 +/- 1.0	4.6 +/- 1.2	<0.001
6 h	3.1 +/- 1.1	5.2 +/- 1.4	<0.001
12 h	3.4 +/- 1.2	4.5 +/- 1.3	<0.001
24 h	2.7 +/- 1.0	3.2 +/- 1.1	0.037

Table 3: Analgesic consumption and adverse events

Outcome	TAP group	IV group	p-value
Time to first rescue analgesia (h)	8.6 +/- 3.1	3.4 +/- 1.5	<0.001
Tramadol in 24 h (mg)	82.5 +/- 37.8	168.0 +/- 55.4	<0.001
Patients requiring >=2 rescue doses	9 (22.5%)	26 (65.0%)	<0.001
PONV	4 (10.0%)	11 (27.5%)	0.045
Patient satisfaction score	8.7 +/- 1.0	7.1 +/- 1.3	<0.001
Block-related complication	0	-	-

Discussion

The trial results showed that ultrasound-guided TAP block provided excellent early postoperative pain relief with a marked decrease in opioid usage when compared to IV-analgesia. A clinically significant reduction in tramadol use was observed as it is known that opioid-related side effects such as nausea, dizziness, and sedation often prevent patients from obtaining a successful outcome [11].

The analgesic effect seemed to be highest during the first 12 hours, in line with the typical duration of action for a single-shot bupivacaine TAP block. TAP block primarily works for the pain over the abdominal wall and visceral pain may be felt after intra-abdominal surgery. Thus, the use of TAP block should be viewed as a multimodal approach to analgesia and not as an analgesic technique in isolation [12]. It is significant that the lower rate of PONV in the TAP group. This study wasn't designed to measure whether PONV was reduced, but it is a reasonable assumption that decreased opioid use played a role in decreasing symptoms. This could be due to improved pain management and reduced opioid effects, as these factors all contribute to increased satisfaction [13]. Safety may have been enhanced by ultrasound guidance as it enabled visualization of the fascial planes and needle tip. Blind landmark TAP techniques are subject to error as the layers of muscles are

different in different body habitus. In real-time imaging, it is possible to confirm the spread of hydrodissection and local anesthetic [14]. Care must be taken in local anesthetic dose when performing bilateral TAP block. The dose should be incremental by repeated aspiration and it should be based on body weight. In this study, toxicity was not encountered, yet safety measures are still crucial in clinical applications.

Limitations include single-center design, heterogeneous abdominal procedures and lack of sham block. Patient expectation may have an impact on subjective satisfaction. But opioid use and rescue dose frequency were protocol outcome measures. Comparisons with quadratus lumborum block and wound infiltration and epidural analgesia should be made in future trials [15].

One of the strengths of TAP block is that can be used in conjunction with general anesthesia without causing bilateral weakness of the lower limb, urinary retention or hypotension. The ability to distinguish it from neuraxial analgesia and the fact that it is appealing in certain abdominal procedures where an epidural would be overindulgent, make it well suited for certain procedures.

The block needs to correspond to the incision location. The lateral TAP approach provides better lower abdominal wall coverage than upper abdominal coverage. In the case of subcostal incisions a subcostal TAP or another fascial plane block might be more suitable. Thus, procedure-specific block selection is a must.

Reduction of PONV promotes opioid-sparing analgesia as a recovery strategy. Nausea has been found to delay oral intake and mobilization after surgery in many patients with abdominal surgery. Even if a regional technique does not provide an adequate reduction in opioid requirements, it can enhance comfort.

The success of blocks is influenced by training and image quality. The three layers of muscle must be distinguished and local anesthetic spread is important. The analgesic effect may be diminished if the injectate spreads between the muscle layers instead of within the muscle layers. Reliability could be enhanced with structured teaching and documentation.

The study also emphasizes the need for dynamic assessment of pain. The pain during coughing, sitting and ambulation may not be accurately recorded by resting VAS. It is important to recognise that the patient undergoing an abdominal surgery has to breathe and move early, so movement-related pain may be more of a concern than rest pain.

Single-shot TAP block is a relatively easy to perform block that is only temporary. The decrease in pain scores at 24 hours indicates convergence of pain scores and further planning for analgesia should be considered beyond the duration of the block. Hence, early satisfactory pain relief should not be an excuse to stop scheduled non-opioid analgesics.[8] There may also be less variation in recovery since the number of rescue tramadol has decreased. Repeated opioids may cause patient's sedation, nausea, dizziness, and delayed oral intake. TAP block can help with a smoother recovery path by decreasing the need for rescue opioid.

The findings of this study should not give anyone cause for complacency as no block complications occurred. The knowledge of sonoanatomy, safe needle advancement and local anesthetic dose limits is required for fascial plane blocks. Institutions implementing such blocks should have protocols for training, documentation and toxicity management.

Future studies could be helpful by stratifying abdominal procedures in terms of incision level. A single TAP approach may not be equally effective for all operations. Comparing lateral, posterior, subcostal and oblique subcostal techniques might provide more specific recommendations for each procedure.

The value of TAP block is highest when used in a comprehensive analgesic protocol in everyday practice. Paracetamol, NSAIDs (if appropriate), and antiemetic prophylaxis and early mobilization should be continued following the block. A period of block should also be communicated to ward staff to prepare for giving analgesics before excessive rebound pain occurs. This synchronized strategy avoids the excessive use of one injection, and ensures the opioid-sparing effect is more uniform between patients and surgical teams.

The value of TAP block in today's practice is most important when used in conjunction with an overall analgesic regimen. Post-block Paracetamol and appropriate NSAIDs to be continued, and also antiemetic prophylaxis and early mobilization instructions. This should also be conveyed to the ward staff by the anesthesiologist in order to ensure that analgesics are administered before a painful rebound occurs. This team-based approach helps to avoid relying on a single injection and helps ensure a more uniform opioid-sparing effect among patients and surgical teams.[11]

The study also has implications on the use of resources. A brief ultrasound guided block can help decrease the need for repeat rescue analgesics during the peak pain phase. In the OR it takes a few minutes but could save time in recovery and on the ward because of decreased pain calls, nausea

treatment and pain monitoring for opioids. The formal economic analysis may be helpful in future studies. It is still crucial to select patients. The most beneficial effect of TAP block is when abdominal wall pain is a significant part of the pain problem. Systemic analgesics may be necessary for patients who are undergoing procedure with broad visceral manipulation. So, it is important to explain the technique as an "opioid-sparing" technique, rather than a means to 100% pain relief.

Conclusion

In elective abdominal surgery, ultrasound-guided bilateral TAP block showed greater early postoperative analgesia, longer time to first rescue analgesia and less 24-hour opioid consumption and PONV than intravenous analgesia alone. It can be a helpful tool of multimodal analgesia when done by a trained clinician.

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