e-ISSN: 0975-5160, p-ISSN: 2820-2651

Available online on www.ijtpr.com

International Journal of Toxicological and Pharmacological Research 2024; 14(6); 136-141

Original Research Article

Effectiveness of Ultrasound-Guided TAP Block for Postoperative Pain Relief in Abdominal Surgeries

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Received: 18-03-2024 / Revised: 21-04-2024 / Accepted: 26-05-2024

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Conflict of interest: Nil

Abstract:

Background and Aim: The transversus abdominis plane (TAP) block is a modern and highly effective technique used to provide postoperative pain relief for individuals who have undergone lower abdominal surgeries. In this study, we will be comparing two techniques of TAP block for postoperative analgesia in abdominal surgeries.

Material and Methods: A total of 100 patients, ranging in age from 18 to 60 years old, and classified as ASA grade I-II, are scheduled for various abdominal surgeries including appendicectomy, appendicular perforation, umbilical, paraumbilical, incisional and ventral hernia repair, hysterectomy, and exploratory laparotomy under general anesthesia. The participants were split into two groups, with each group receiving either a blind or USG-guided TAP block. After the procedure was completed, just before the reversal, both groups were given a TAP block with Inj. Bupivacaine 0.25% 20cc on each side while lying on their backs. Patients were monitored for duration of 24 hours; with pain levels assessed using a visual analogue scale. We recorded the total amount of pain medication needed over a 24-hour period and documented any complications that arose.

Results: The results showed a significant prolongation in the time to first rescue analgesic in the group that used USG guidance, compared to the blind technique. This suggests that the use of USG allows for a more precise TAP block. The USG-guided group demonstrated a significantly better efficacy score ($p<0.05$) compared to the other group. This indicates improved analgesia and reduced need for additional pain medications.

Conclusion: Utilizing ultrasound technology allows for more accurate administration of local anesthesia in the correct location, although it does require a steeper learning curve. Considering the TAP block as part of multimodal analgesia and enhanced recovery in patients undergoing abdominal surgery is highly recommended. This technique offers a simple, safe, and easy way to achieve improved analgesia.

Keywords: analgesia, abdominal surgery, Postoperative analgesia, Transversus abdominis plane.

Introduction

Postoperative pain can be a significant challenge for patients who have just undergone surgery. Effective postoperative pain relief is essential for addressing this issue. Postoperative pain in lower abdominal surgeries typically arises from the incision made in the abdominal wall. [1] The muscular layer of the abdominal wall receives innervation from nerve afferents that pass through the Transversus Abdominis neurofascial plane. [2]

While there are various techniques and medications available to provide postoperative pain relief, opioids are the only ones that truly deliver adequate relief. However, opioids can have extremely negative consequences. Therefore, there is a growing recognition of the importance of regional blocks and local anesthesia drugs in order to minimize the reliance on opioids. The TAP block is a technique that helps relieve pain by blocking the sensory nerve supply to the front of the abdomen. [3.4]

The TAP block is a new method of administering local anesthesia by injecting it into the space between the internal oblique and transversus abdominis muscles. The anterior abdominal muscular wall receives innervation from nerve afferents that travel through the transversus abdominis neuro-fascial plane. The anterior rami of spinal nerves T7-L1 provide innervation to the

anterolateral abdominal wall. It offers pain relief to the parietal peritoneum, skin, and muscles of the anterior abdominal wall. The TAP block has been found to be effective in reducing post-operative pain, decreasing the need for opioids after surgery, minimizing respiratory complications, promoting early ambulation, and reducing postoperative nausea and vomiting. It has also shown positive results for patients with multiple comorbidities. There are different techniques available for performing this procedure, including blind or ultrasound guided methods. The ultrasound guided technique is generally considered to have higher success rates and accuracy. [5,6] This study aims to compare the blind technique with the USG-guided technique of TAP block for postoperative analgesia in abdominal surgeries, as there are limited studies available for comparison.

Material and Methods

The study was conducted in a tertiary care hospital, following approval from the Institutional Ethics Committee. Patients between the ages of 18 and 60, regardless of gender, who were in good physical condition and scheduled for elective abdominal surgery, were eligible for inclusion in the study. All patients were provided with a thorough explanation of the procedure before obtaining their informed consent. Based on the study conducted by Shrikanta Oak, it was determined that a minimum sample size of 50 in each group is required. This calculation was made using a 95% confidence interval and 80% power, with a mean difference of 20 minutes in total duration of analgesia. [7]

The randomization process involved the use of computer-generated chits to select the technique. This study aims to assess the effectiveness of TAP block for postoperative pain relief in abdominal surgery. It is a prospective, randomized, observational study. The main focus was to compare two techniques of TAP block: the landmark guided blind technique and the ultrasound guided technique, as well as to determine the total duration of analgesia achieved. Additional goals were to assess the changes in pain levels after surgery using the Visual Analogue scale (VAS), the amount of additional pain medication needed within 24 hours, the frequency of breakthrough pain medication required, and any potential side effects or complications.

Patients meeting the inclusion criteria included those who were in ASA physical class I or II and were scheduled for abdominal surgery. The age group ranged from 18 to 60 years and included both males and females. Additionally, these patients provided informed consent. Exclusion criteria for this study include patient refusal, patients with ASA III and IV classifications, individuals with coagulation disorders, those with systemic illnesses like cardiac, respiratory, and neurologic/neuromuscular disorders, individuals with allergies to local anesthetics, and those with local site infections.

Procedures such as appendicectomy, appendicular perforation, umbilical, paraumbilical, incisional and ventral hernia repair, and gynaecological procedures like hysterectomy and exploratory laparotomy were included. All patients underwent thorough evaluations and necessary investigations were conducted in accordance with institutional protocols. Every patient received a thorough explanation of the procedure, including the potential risks, benefits, and drawbacks. They were also informed about the effects of the medication and the necessary monitoring that would be conducted.

During the day of the operation, once the patient's fasting status was confirmed, they were escorted to the operating room and given intravenous RL fluid through an 18 G i.v. needle. Continuous monitoring of heart rate (three-lead ECG), non-invasive arterial pressure, oxygen saturation, and end-tidal CO2 was performed throughout the perioperative period. Patients received premedication consisting of intravenous administration of Pantoprazole 40mg, Glycopyrrolate (0.004mg/kg), and Midazolam (0.03mg/kg). Administered intravenously were Fentanyl (2mcg/kg), Propofol (2mg/kg), and Succinylcholine (2mg/kg). Patients were administered Oxygen: Nitrous oxide (50:50), along with Inhalational agent: Sevoflurane/ Isoflurane and muscle relaxant: Inj. Atracurium IV/ Inj. Vecuronium IV. A dose of 1gm of Paracetamol was administered intravenously during the surgery, one hour after the anesthesia was induced.

As part of the procedure, a TAP block was administered before reversal. The technique was selected using a computer-generated chit, as per the pre-allocated groups. Group A underwent a TAP block procedure guided by ultrasound. Group B underwent a blind TAP block procedure. Each group received 20ml of 0.25% Inj. bupivacaine on both sides, with a maximum dose of 1 mg/kg on each side.

The patients received a USG guided block while lying on their backs. The skin was prepared with a povidone-iodine solution, and a high-frequency linear ultrasound probe with a depth of penetration of 5cm was cleaned and covered with a sterile cover after applying sterile ultrasound gel. The probe was positioned horizontally on the front side of the abdomen, specifically between the bony ridge of the hip and the lower edge of the ribcage. I have successfully identified the three muscles of the anterior abdominal wall. Once the neuro-fascial plane between the internal oblique and the transversus abdominis muscle was located, a 22 G

Quincke needle was carefully inserted in the same direction as the ultrasound beam. When entering the fascial plane, bupivacaine injection was administered after ensuring there was no aspiration. There is a noticeable spread of the drug, forming a distinct dark oval shape. Additionally, there is a triangular area known as the Petit triangle, located between the external oblique and iliac crest. With the advancement of the needle, there are distinct "pop" sensations as it pierces the external and internal oblique fascial layers. This is followed by the administration of local anesthetic, which is then repeated on the opposite side. Measurements were taken at comparable time intervals. Patients were administered Inj. Paracetamol 1g post-operatively every 6 hours if their pain level, as measured by the VAS, exceeded 4. In cases where pain persisted despite a Diclofenac injection, patients were given Inj. Tramadol 100 mg IV if their VAS score was above 7.

PACU discharge score was recorded based on 5 parameters, postoperatively at 24 hours, before discharging the patient from PACU to the ward. 6 scores were given out of 2, in each group.

1. Vital signs: 2- BP, PR within 20% of pre-op; 1- BP, PR between 20-40%; 0- BP, PR >40%. 2. Activity level: 2- ambulate without assistance; 1- ambulate with assistance; 0- cannot ambulate.

3. Nausea and vomiting: 2- treated with oral medication; 1- treated with parenteral medication; 0- vomiting persist even with treatment.

4. Pain: 2- controlled by analgesics and acceptable; 1-not acceptable even after analgesics.

5. Surgical bleeding: 2- does not require a dressing change; 1- two dressing changes required; 0- ≥3 dressing changes required.

The efficacy score was measured using 4 parameters[8], each scored out of 2

1. VAS range: 2- VAS 0-4; 1- VAS 4-7; 0- VAS 7-10.

2. PONV: 2- no nausea vomiting; 1- nausea only; 0- vomiting also.

3. Respiratory depression: 2-Spo2- >94% on RA, RR12-20 bpm; 1- Spo2- 90-94% on RA, RR- 8-11 bpm; 0- Spo2< 90% on RA, RR-<8 bpm

Patients were monitored for complications like inadvertent peritoneal puncture, abdominal wall hematoma, nausea, vomiting, nerve injury, intravascular injection, etc.

Statistical analysis

The data was compiled and entered into a spreadsheet computer program (Microsoft Excel 2019) and then exported to the data editor page of SPSS version 15 (SPSS Inc., Chicago, Illinois, USA). Quantitative variables were reported using either means and standard deviations or median and interquartile range, depending on their distribution. The presentation of qualitative variables was in the form of counts and percentages. Confidence level and level of significance were set at 95% and 5% respectively for all tests.

Results

The patients in both groups had similar demographic data and duration of surgery, as shown in Table 1. The pain scores at various time intervals after surgery were compared between the USG guided group and the blind group. From the initial postoperative period until 20 minutes, the pain scores were similar in both groups. However, starting from 30 minutes until 12 hours, the pain scores were significantly lower in the USG guided group compared to the blind group. After 16 hours, the pain scores became comparable again between the two groups.

The time it took to administer the first rescue analgesic was significantly longer in the group that used USG-guided technique, with an average of 19.68 ± 4.90 hours, compared to the blind technique which took an average of 13.48 ± 6.86 hours ($p<0.05$). This indicates that the use of USG allowed for a more precise TAP block. In the group that received ultrasound-guided treatment, the average number of rescue analgesics needed was 1.225 ± 0.61, while in the blind group it was 1.55 ± 0.67. This indicates a significantly lower need for rescue analgesics in the ultrasound-guided group ($p<0.05$).

The PACU discharge score, which took into account vital signs, activity level, postoperative nausea and vomiting (PONV), pain scores, and surgical bleeding, was found to be significantly higher in the group that used ultrasound-guided techniques (9.025 ± 1.31) compared to the group that relied on blind techniques (8.1 ± 1.73) ($p < 0.05$).

The USG-guided group showed a significantly better efficacy score ($p<0.05$), indicating improved analgesia and reduced need for additional pain medication. This was evident from the VAS score range, PONV, respiratory depression, and sedation. (Refer to Table 2) In the Blind technique group, 10% (n=4) of patients experienced block failure, while in the USG-guided group, only 5% (n=2) of patients had block failure. No other complications were encountered during the rest of the process.

Table 1: Demographic characteristics of patients

Group	Blind (n=40)	USG Guided (n=40)	P value
Age (Mean ± SD	42.05 ± 12.45	40.87 ± 11.22	0.45
Sex (M/F)	25/25	28/22	0.22
Weight (Mean ± SD)	63.45 ± 12.10	62.80 ± 11.90	0.09
Duration of surgery (Mean ± SD)	170.10 ± 45.22	171.05 ± 62.14	0.07

Statistically significance at p≤0.05

Table 2: Efficacy score

Group	Blind TAP (Mean Score)	USG – Guided TAP (Mean Score)	P- Value
VAS Range	0.73 ± 0.4	0.94 ± 0.44	**0.02***
PONV	1.54 ± 0.70	1.83 ± 0.35	**0.001***
Respiratory	1.93 ± 0.25	2.1 ± 0.4	**0.1**
Depression	1.96 ± 0.30	1.98 ± 0.24	**0.65**
Sedation	6.16 ± 1.54	6.77 ± 0.90	**0.03***

*** Indicate statistically significance at p≤0.05**

Discussion

Postoperative pain management typically involves a combination of different methods. Various techniques are employed to directly block the neural afferents of the abdominal wall, such as abdominal field blocks, illio-inguinal blocks, and hypogastric nerve blocks. They have been commonly utilized to provide pain relief after lower abdominal surgeries. Research has demonstrated that using effective pain relief methods can have a positive impact on various aspects of postoperative care, including reducing stress, promoting faster recovery, facilitating early mobilization, and enabling earlier discharge. A new regional analgesic technique called. [9-11]

TAP analgesia is becoming increasingly popular for managing postoperative pain. The extent of its involvement in major abdominal surgery remains uncertain. Research has shown that the TAP block has been effective in providing sufficient pain relief after lower abdominal surgeries. Additionally, it has been found to decrease the need for opioid pain medication.

Studies by Shrikanta Oak et al [12] and Wafaa Mohamed Alsadek et al [13] have shown that the appropriate block can provide prolonged and improved pain relief, reducing the need for additional rescue analgesics. There is a wide range of variation in the need for analgesics due to the subjective nature of pain tolerance and perception. Both groups had similar requirements for innovative pain relievers. Our findings closely resemble those of the studies conducted by G. Neeraj et al and Neerja Bharti et al. [14]

After 24 hours, the patient's PACU discharge score was evaluated prior to their transfer from the PACU to the ward. Poor pain management greatly impacts the parameters for PACU discharge. In the study conducted by Aparna Sinha et al., it was found that the PACU discharge score was significantly better in the USG-guided group compared to the blind group. The score was 9.025± 1.31 in the USG-guided group and 8.1 ± 1.73 in the blind group ($p<0.05$). This indicates that the USG-guided group experienced better postoperative analgesia for 24 hours. [7] A study conducted by Khan et al. found that using USG-guided TAP block during lower abdominal surgeries provides effective pain relief during and immediately after the operation. [15]

Comparing the overall efficacy of two techniques of TAP block, an efficacy score was utilized. It assesses post-operative pain using the VAS score, examines potential complications such as PONV and Respiratory depression, evaluates the effectiveness of the block, explores the effects of tramadol use, and compares the two techniques of TAP block. In a study conducted by Desale Tewelde Kahsay et al, it was found that the group using USG-guided technique experienced significantly lower levels of pain and postoperative nausea and vomiting (PONV) compared to the group using the Blind technique. As a result, the Efficacy score was significantly better in the USG-guided group. [8] According to Shibita's report, the TAP block has been found to provide sensory block up to T10 in gynecological procedures. However, it is recommended to use this technique specifically for lower abdominal surgery. [12] According to Laffey, there may be some misleading aspects to the upper level of the TAP block before it fully spreads. The full block height was measured gradually over several hours following the completion of the performance. [16]

Ultrasound technique has the potential to enhance the effectiveness and safety of block procedures. For abdominal surgeries, a single shot nerve block can greatly improve patient compliance compared to multiple epidural top-ups. It is suitable for patients with limited cardiovascular capacity and those who are hemodynamically unstable. Additional studies on USG guided TAP block through various approaches, as well as four

quadrant blocks, can contribute to improved post-operative pain relief for large incisions that extend to the upper abdomen. In a recent study by Rouholamin et al., the researchers found that the use of 0.5% ropivacaine in TAP block had a notable impact on decreasing postoperative pain after laparoscopic surgeries. [17]

In addition, the use of opioids was restricted and there were no significant complications. Our study revealed that using ropivacaine 0.375% for TAP block can effectively reduce postoperative pain. This effect is particularly noticeable in patients who undergo lower abdominal surgeries with spinal anesthesia rather than general anesthesia. In a study conducted by Wan et al. [18], the researchers examined the systemic toxic effects of various concentrations of ropivacaine and lignocaine on rats.

Researchers discovered that the use of 0.5% ropivacaine resulted in fewer systemic toxic effects when compared to the use of 1% ropivacaine. Based on the information provided, a concentration of 0.375% ropivacaine was selected as a safe option for the TAP block in our study, in order to avoid any potential systemic toxic effects.

The study did not encounter any complications associated with the technique, such as local site hematoma, nerve/vessel injury, peritoneal or organ penetration, intravascular injection, and so on. With experience and expertise in procedure, this can be easily eliminated. Our study had some limitations. We did not consider the type of incision, whether it was transverse or vertical. Additionally, blinding was not implemented.

Conclusion

The use of ultrasound facilitates more precise injection of local anesthetic in the right plane but requires a higher learning curve. TAP block should be considered as part of multimodal analgesia and enhanced recovery in patients undergoing abdominal surgery, as it is a simple, safe, and easy technique with better analgesia.

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