World Journal of Surgery and Surgical Research

Research Article
Published: 16 Dec, 2024

Analgesic Efficacy of Ultrasound-Guided Lateral Transversus Abdominis Plane Block for Open Appendectomy: A Volume Comparison Randomized Control Trial Study

Pajina B[1], Tiyaprasertkul W[2], Thawillarp S[3] and Nakazawa K[4]*

[1]Nan Hospital, Nan, Thailand

[2]Bangkok Hospital Chiang Mai International, Chiang Mai, Thailand

[3]Department of Health Policy and Management, John Hopkins University, USA

[4]Department of Anesthesiology, Nihon university school of medicine, Tokyo

Abstract

Introduction: The optimal volume of Local Anesthetic (LA) for the Transversus Abdominis Plane (TAP) block in managing postoperative pain remains controversial. This study aimed to determine whether smaller volumes of LA provide comparable analgesic efficacy during the postoperative period.

Methods: Ninety patients undergoing open appendectomy were randomly assigned to three groups to receive a right lateral TAP block with 0.25% bupivacaine in different volumes: TAP1 received 10 ml, TAP2 received 15 ml, and TAP3 received 20 ml. The primary outcome was postoperative pain scores within the first 24 hours. Secondary outcomes included opioid consumption, time to first analgesic requirement, and any complications.

Results: TAP3 exhibited significantly lower mean Visual Analog Scores (VAS) compared to TAP1 and TAP2 at all time points ($p < 0.05$), both during movement and at rest. Opioid consumption was also significantly lower in TAP3 compared to TAP1 and TAP2 ($p < 0.05$). Fewer patients in TAP3 requested additional analgesia. There were no significant differences in the time to first opioid requirement, and no complications related to the TAP block procedure were recorded.

Conclusion: The volume of LA in a TAP block affects analgesic outcomes. While a 10 ml volume can provide adequate analgesia after open appendectomy, a 20 ml volume significantly reduces pain scores and opioid consumption.

Keyword: TAP; Open appendectomy; Postoperative pain

OPEN ACCESS

Correspondence:
Burapa Pajina, Nan Hospital, Nan, Thailand,

Received Date: *22 Nov 2024*
Accepted Date: *11 Dec 2024*
Published Date: *16 Dec 2024*

Citation:
Pajina B, Tiyaprasertkul W, Thawillarp S, Nakazawa K. Analgesic Efficacy of Ultrasound-Guided Lateral Transversus Abdominis Plane Block for Open Appendectomy: A Volume Comparison Randomized Control Trial Study. World J Surg Surgical Res. 2024; 7: 1582.

Introduction

Post-operative pain is a common issue for patients undergoing open appendectomy, with many experiencing mild to moderate pain after surgery. Effective acute pain management is essential to relieve pain and discomfort while minimizing adverse effects. Adequate pain control is critical, as poorly managed pain can negatively impact quality of life, daily functioning, and recovery. It may also prolong hospital stays, lead to surgical complications, and increase the risk of developing persistent post-surgical pain [1].

Regional anesthesia is an effective method for post-operative pain management. Current knowledge suggests that the Lateral Transversus Abdominis Plane (LTAP) block provides effective post-operative analgesia in patients undergoing open appendectomy [2,3]. The aim of the LTAP procedure is to deposit Local Anesthetic (LA) into the intermuscular space between the internal oblique abdominis muscle and the transversus abdominis muscle, targeting the thoracolumbar nerve [4,5].

A relatively large volume of LA is often required to achieve adequate analgesic effect. Although the minimum effective volume of LA remains unclear, the tendency is to administer at least 15 ml [6]. This study was designed to determine if lower volumes of LA have the same analgesic efficacy

for open appendectomy under general anesthesia.

Material and Methods

After obtaining approval from the Ethics Committee of the Provincial Health Center and written informed consent, ninety patients underwent open appendectomy in our hospital from April 2020 to March 2021 [Anonymized]. Patients classified as American Society of Anesthesiologists (ASA) I-III, aged 18 to 80 years, were included. Exclusion criteria were: 1) Ruptured Appendicitis; 2) Body Mass Index (BMI) > 35 kg/m^2; 3) allergy to any study medication; 4) Pregnancy; 5) Chronic opioid use; and 6) Coagulation Disorders.

Patients were randomized using sealed envelopes into three groups (30 patients in each group) and gave written inform consent to participate in this study. Each group received an LTAP block with 0.25% bupivacaine in different volumes: Group 1ml to 10 ml (TAP1); Group 2 ml to 15 ml (TAP2); and Group 3 ml to 20 ml (TAP3) (Figure 1).

Agents were prepared immediately after randomization by an independent nurse who was not involved in block performance or data collection. An ultrasound-guided lateral TAP block was performed on the right side of all patients by the anesthesiologist. Before the operation, a linear transducer was placed transversely in the mid-axillary line at the midpoint between the subcostal margin and the iliac crest. The three layers of abdominal muscles (external oblique, internal oblique, and transversus abdominis) were identified. The needle was inserted into the anterior axillary line, and its tip introduced into the plane between the internal oblique muscle and the transversus abdominis muscle [7,8]. After confirmation of needle placement, 0.25% bupivacaine was injected according to the assigned volumes.

The anesthesiologist assessed the dermatomal sensory effects of each LTAP block using ice to determine the cold sensation. Any area of dermatome sensory blockade was compared to standard dermatome charts for the subcostal margin (T6), the umbilicus (T10), and the inguinal ligament (L1).

All patients received general anesthesia with rapid sequence intubation management. Anesthesia was induced with propofol (2 mg/kg), fentanyl (1 mcg/kg), and succinylcholine (1.5mg/kg to 2 mg/kg) for endotracheal intubation. Following intubation, cisatracurium (0.1 mg/kg) was administered. General anesthesia was maintained using mechanical ventilation with a sevoflurane/O_2/N_2O mixture. Additional fentanyl (0.5 mcg/kg) was administered as needed to keep blood pressure and heart rate within 20% of baseline values. Intraoperative fluid administration was calculated based on the patient's body weight. At the end of the operation, neuromuscular blockade was reversed using neostigmine (0.04 mg/kg) and atropine (0.02 mg/kg). Patients were then transferred to the Post-Anesthetic Care Unit (PACU).

The patients, and the anesthesiologists involved in direct patient care, were unaware of the study group allocation. Patients were interviewed to determine their Visual Analog Scale (VAS) scores at rest and during movement in the first 24 hours of the post-operative period by a ward nurse not participating in this study. Supplementary intravenous morphine (3 mg) was administered when patients reported a VAS score greater than 4. The total consumption of intraoperative fentanyl, the time to the first request for additional analgesia, the number of patients needing analgesic medication, and any adverse effects were recorded.

The primary outcome was the VAS score at rest and during movement in the first 24 hours of the post-operative period. The severity of pain at rest was assessed at 0, 2, 4, 6, 12, and 24 hours. The severity of pain during movement was assessed at 4, 6, 12, and 24 hours. T0 refers to zero time at the Post-Anesthetic Care Unit (PACU). Secondary outcomes included the duration of time from T0 to the first analgesic requirement, total opioid consumption, the number of patients who needed analgesic medication, and any adverse effects.

Results

Statistical analysis

Sample size calculation was based on the numerical rating scale [9] with a significance level of 5% and power of 80%. The calculated sample size included a 20% dropout rate, resulting in 30 patients per group.

Descriptive statistics, including mean, standard deviation, and percentage, were used. One-way ANOVA with Bonferroni-corrected pairwise t-tests was employed to compare VAS scores across the intervention groups at each time point. All statistical analyses were conducted using Microsoft R Open 3.5.3. A p-value of <0.05 was considered statistically significant.

All 90 patients completed this study. Twelve patients were excluded for not meeting the inclusion criteria. The baseline characteristics of the patients were comparable among the three groups (Table 1).

The TAP3 group had a high success rate (>80%) of dermatome block in segments T8 – L1, while the TAP2 group had a high success rate in segments T9 - T12, and the TAP1 group in segments T10 – T12. Dermatome sensory blockade to cold sensation tended to be higher in the TAP3 group (Figure 2).

The intensity of pain both at rest and during movement was compared at different time points among the three groups (Table 2 and Table 3). The mean VAS score at rest was significantly lower at all time points in the TAP3 group compared to the TAP1 and TAP2 groups. The VAS score during movement was significantly lower in the TAP3 group compared to the other two groups at the 4th, 6th, and 24th hours (Table 3).

The number of patients who requested analgesia in the first 24 hours in the TAP3 group was significantly lower than in the TAP1 and TAP2 groups. The total opioid consumption in the TAP1 and TAP2 groups was significantly higher than in the TAP3 group (Table 4). The time to first analgesia was 298.23 minutes in the TAP1 group, 266.10

Table 1: Demographic data and clinical characteristics.

Characteristics	TAP1 (10 ml)	TAP2 (15 ml)	TAP3 (20 ml)	*p*
Age (yr)	48.37	48	46.17	0.6
Weight (kg)	59.53	58.23	60.2	0.66
Height (cm)	158.33	161.43	159.53	0.76
Body mass index (kg/m^2)	23.51	22.82	23.54	0.39
Sex (male/female)	15/15	10/20	11/19	0.38
ASA physical status (I/II/III)	22/7/1	15/11/4	21/9/0	
Average ASA	1.3	1.63	1.3	0.69
Operating time (min)	31.03	33.43	34.4	0.11

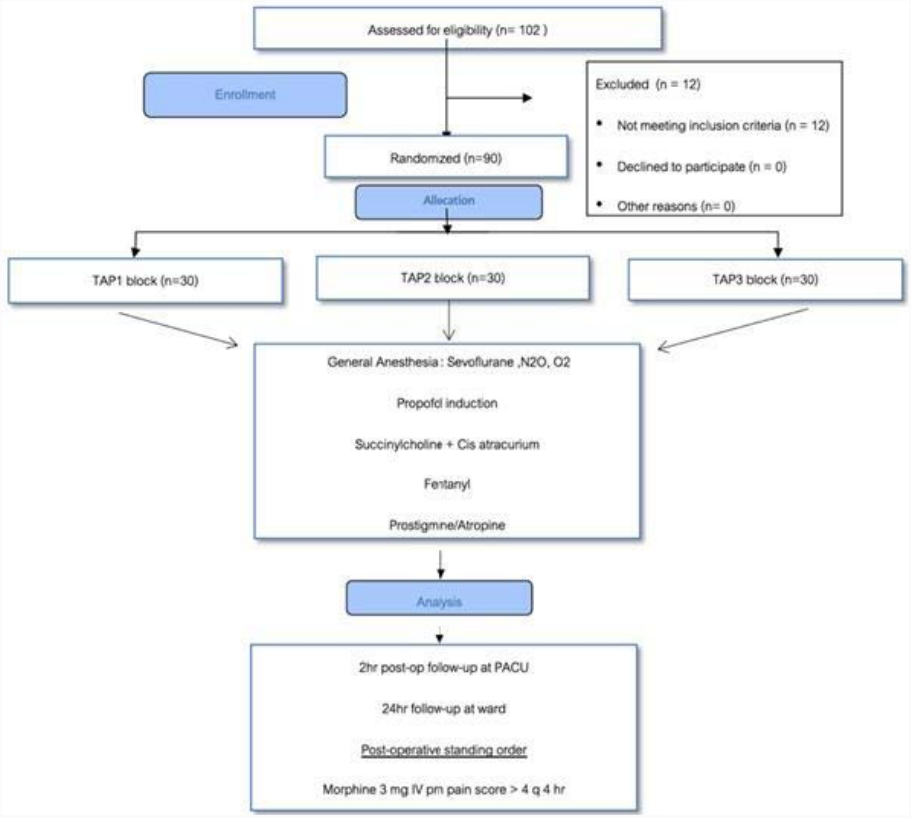

Figure 1: Study Chart Flow.

Table 2: Comparison of VAS score at rest.

VAS (at rest)	TAP1 (10 ml)	TAP2 (15 ml)	TAP3 (20 ml)	*p*
0 minute	2.17	0.87	0.77	<0.05*
2nd hour	4.73	4.03	3.53	<0.05*
4th hour	4.17	2.77	2.37	<0.05*
6th hour	4.03	3.13	2.03	<0.05*
12th hour	2.93	2.17	1.9	<0.05*
24th hour	1.8	1.37	0.43	<0.05*

Table 3: Comparison of VAS score at movement.

VAS (at movement)	TAP1 (10 ml)	TAP2 (15 ml)	TAP3 (20 ml)	*p*
4th hour	5.9	5.33	4.2	<0.05*
6th hour	5.87	5.5	4.27	<0.05*
12th hour	5.03	4.93	4.33	0.05
24th hour	3.8	3.6	3.03	<0.05*

minutes in the TAP2 group, and 258.00 minutes in the TAP3 group, but the difference was not statistically significant. There was also no significant difference in the consumption of intraoperative fentanyl among the three groups. In terms of post-operative complications, only nausea and vomiting were reported, but there was no significant difference among the groups (Table 4). All blocks were performed without any complications.

In terms of total opioid consumption and the number of patients who requested analgesia, there were no significant differences between the TAP1 and TAP2 groups (Table 5).

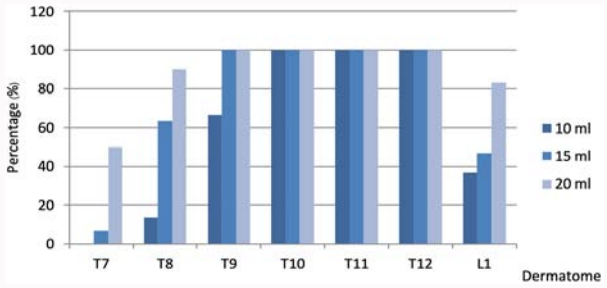

Figure 2: Frequency of sensory blockade.

Discussion

Open appendectomy is one of the most common emergency surgeries among adults worldwide. Although this operation is considered less invasive, open appendectomy still poses significant postoperative pain, comparable in intensity to knee arthroplasty [10]. This can lead to underestimating pain intensity and inadequate pain treatment. Optimal postoperative pain management can minimize opioid consumption, improve early ambulation, and enhance patient satisfaction. Recently, the Transversus Abdominis Plane (TAP) block has gained popularity as a peripheral nerve block and an essential component of multimodal analgesia.

Our randomized controlled trial demonstrated that 10 ml of Local Anesthetic (LA) in a TAP block provided sufficient analgesia for postoperative open appendectomy, functioning as a single agent for postoperative pain management in the absence of multimodal analgesia.

Table 4: Analgesic requirements and complications.

	TAP1 (10 ml)	TAP2 (15 ml)	TAP3 (20 ml)	*p*
Intraoperative fentanyl (mcg)	98.33	96.83	100.67	0.63
Time to first analgesia (min)	298.23	266.1	258	0.65
Total opioid requirement (mg)	4.33	3.37	1.97	<0.05*
No. post-operative analgesia	1.4	1.07	0.67	<0.05*
Complications*	3	2	2	

Table 5: Analgesic requirement (Post ANOVA with Bonferroni correction).

Variable	p-value	TAP1 (10 ml)	TAP2 (15 ml)
Total opioid requirement (mg)	TAP2 (15 ml)	0.49	
	TAP3 (20 ml)	<0.05*	0.14
No. post-operative analgesia	TAP2 (15 ml)	0.42	-
	TAP3 (20 ml)	<0.05*	0.23

In 2001, Rafi first described the TAP block as an anatomical landmark technique. The ultrasound-guided TAP block has since become more effective and popular. Multiple trials have shown that patients receiving a TAP block for abdominal surgery experience lower postoperative pain scores, reduced intraoperative opioid consumption, and decreased analgesia requirements [11-14].

There is no clear consensus regarding the optimal volume of LA for a TAP block, leading some researchers to use varying volumes [15]. Our study is the first to evaluate the effect of different LA volumes on analgesic efficacy. We found no significant differences in the time to first analgesia requirement, intraoperative opioid consumption, or side effects among the groups. However, there were significant differences in total opioid requirement and the number of patients requesting analgesia between the TAP1 and TAP3 groups, although these differences were not clinically significant.

Our results indicated that 10 ml of LA in a TAP block can provide effective analgesia after open appendectomy. This finding is consistent with a previous study [16], which demonstrated that both high and low volumes of local anesthetic could provide adequate analgesic effects in children undergoing open appendectomy.

The two main sources after open appendectomy, namely somatic pain from surgical incision and visceral pain due to the inflammation process. TAP block could minimize somatic pain from surgical wound. However, the first time of opioid requirement is considered the duration analgesic of TAP block. Our study has shown a mean duration of analgesic ranging from 258 mins to 298 mins. This result was supported by previous study that demonstrating the analgesic efficacy of TAP block has been variation varied from 0 to 12 postoperative hours [17]. Moreover, our study also illustrated the number of patients receiving intravenous morphine all groups were similar likely due to the relatively small incision size of 2 cm to 3 cm.

In our study, a high success rate of dermatome block in segments T10-T12 was achieved in the TAP1 group (10 ml). This result aligns with previous findings [18], showing that T10-T12 segments were completely blocked (100%) after injecting 10 ml of 0.25% bupivacaine. This suggests that 10 ml of LA is adequate for analgesia in open appendectomy, which involves surgical incisions around dermatome segments T11 to T12 [19]. Additionally, we considered BMI for patient selection, with a range of 22.82 kg/m² to 23.54 kg/m² ($p = 0.76$), ensuring that patient size did not impact LA distribution.

Intravenous opioids are the standard pain control regimen for open appendectomy at our hospital. Therefore, 10 ml of TAP block could be considered as part of multimodal analgesia, especially when combined with other medications, leading to more effective pain management compared to opioids alone.

Conclusion

The ultrasound-guided TAP block can reduce patients' pain scores and total opioid consumption in the postoperative period.

Although 20 ml of LA significantly reduces pain scores and opioid consumption, 10 ml of LA provides adequate analgesia after open appendectomy and can be utilized as part of multimodal analgesia.

Limitation

Our trial has several limitations. First, we did not include a comparison between a sham block and the use of 10 ml of Local Anesthetic (LA) in the TAP block, although prior studies suggest that a volume of at least 15 ml of LA is necessary for significant analgesic effects compared to a control group. Second, while multimodal analgesic regimens are typically employed to optimize postoperative pain management in open appendectomy, our study was limited to intravenous opioids and the TAP block as the primary modalities, which may have affected the overall pain control outcomes.

Further Study

Investigating the effects of using higher volumes than 20 ml may be the subject of further research.

Contributors

All authors made significant contributions to the study.

Acknowledgement

We would like to express our sincere gratitude to the dedicated team in the post-anesthetic care unit and the anesthesiology nurses for their exceptional diligence, patience, and unwavering support throughout the study. Their commitment to patient care and professionalism has been invaluable to the success of this research.

Conflict of Interest

The authors declare no competing interests.

Data Availability

The data will be available upon request during submission or after publication.

Informed Consent

Written informed consent was obtained from all patients before the research.

Research Support

There was no funding/support.

References

1. American Society of Anesthesiologists Task Force on Acute Pain Management. Practice guidelines for acute pain management in the perioperative setting: an updated report by the American Society of Anesthesiologists Task Force on Acute Pain Management. Anesthesiology. 2012;116(2):248-73.

2. Serpil B, Sibel O, Fatma K, Mehmet B. Ultrasounded-guided transversus abdominis block vs wound infiltration in patients undergoing open

appendectomies. Med Sci. 2018;7(3):634-8.

3. Mehmet Z, Onur P, Karem K, Ali M, Enes B, Volkan O, Metin E, Fehmi, Erdal B. Effectiveness of tranversus abdominis plane block of laparoscopic appendectomy in non-perforated acute appendicitis. Laparosc Endosc Surg Sci. 2018;25(4):133-9.
4. Ma J, Jiang Y, Tang S, Wang B, Lian Q, Xie Z, et al. Analgesic efficacy of ultrasound-guided subcostal transversus abdominis plane block. Medicine (Baltimore). 2017;96(10):e6309.
5. Tomonori F, Jitsa K, Yusuke Y, Noriya H, Takahiro S. Comparision of deramtomal sensory block following ultrasound-guided tranversus abdominis plane block by the lateral and posterior approaches: A randomized controlled trial. J Anaesthesiol Clin Pharmacol. 2018;34(2):205-10.
6. Tran DQ, Bravo D, Leurcharusmee P, Neal JM. Transversus abdominis plane block; a narrative review. Anesthesiology. 2019;131(5):1166-90.
7. Carney J, Finnerty O, Rauf J, et al: Studies on the spread of local anaesthetic solution in transversus abdominis plane blocks. Anaesthesia. 2011;66(11):1023-30.
8. Rafi AN. Abdominal field block: A new approach via the lumbar triangle. Anasethesia 2001;56(10):1024-6.
9. Ghimire A, Bhatthrai B, Prasad JN, Subedi A, Thapa P, Limbu PM, Adhikari S. Postoperative analgesic effect of morphine added to bupivacaine for tranversus abdominis plane (TAP) block in appendectomy. Kathmandu Univ Med J. 2017;17(58): 137-41.
10. Gerbershagen HJ, Aduckathil S, Wijck AJMV, Peelen LM, Kalkman CJ, Meissner W. Pain intensity on the first day after surgery: a prospective cohort study comparing 179 surgical procedures. Anesthesiology 2013;118(4):934-44.
11. Singh S, Dhir S, Marmai K, Rehou S, Silva M, Bradbury C. Efficacy of ultrasound-guided tranversus abdominis plane block for post-cesarean delivery analgesia: a double-blind, dose-comparison, placebo-controlled randomized trial. Int J Obstet Anesth. 2013;22(3):188-93.
12. Kandi Y. Efficacy of ultrasound-guided tranversus abdominis plane block versus epidural analgesia in pain management following lower abdominal surgery. Ain-Sham Journal of anesthesiology. 2015;8(4): 653-7.
13. Belavy D, Cowlishaw PJ, Howes M, Phillips F. Ultrasound-guided tranversus abdominis plane block for analgesia after cesarean delivery. Br J Anaesth. 2009;103(5):726-30.
14. Serpill B, Sibel O, Fatma K, Mehmet BB. Ultrasound-guided tranversus abdominis plane block vs wound infiltration in patients undergoing open appendectomies. Medicine science international medical journal. 2018;7(3):634-8.
15. Abdallah FW, Chann VW, Brull R. Tranversus abdominis plane block: A systemic review. Reg Anesth pain Med. 2012;37(2):197-209.
16. Karadeniz MS, Atasever AG, Salviz EA, Bingül ES, Çiftçi H, Dinçer MB, et al. Transversus abdominis plane block with different bupivacaine concentrations in children undergoing unilateral inguinal hernia repair: a single-blind randomized clinical trial. BMC Anesthesiol. 2022;22(1):355.
17. Abdallah FW, Laffey JG, Halpern SH, Brull R. Duration of analgesic effectiveness after the posterior and lateral transversus abdominis plane block techniques for transverse lower abdominal incisions: a meta-analysis. Br J Anaesth. 2013;111(5):721-35.
18. Carney J, Finnerty O, Bergin D, Laffey JG, Mc Donnell JG. Study on the spread of local anesthetic solution in tranversus abdominis plane block. Anaesthesia 2011;66(11):1023-30.
19. Dahiya DS, Akram H, Goyal A, Khan AM, Shahnoor S, Hassan KM, et al. Controversies and Future Directions in Management of Acute Appendicitis: An Updated Comprehensive Review. J Clin Med. 2024;13(11):3034.