Section: General Surgery

Original Research Article

A RANDOMISED CONTROLLED TRIAL TO STUDY THE ANALGESIC EFFICACY OF TRANSVERSUS ABDOMINIS PLANE BLOCK FOR ADULT UNDERGOING ELECTIVE LAPAROSCOPIC APPENDECTOMY

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ABSTRACT

Background: Laparoscopic appendectomy has become the standard surgical approach for the management of acute appendicitis in adults. Although minimally invasive, postoperative pain remains a significant concern, often requiring systemic opioids which may be associated with undesirable side effects. The transversus abdominis plane (TAP) block has emerged as a promising regional anesthesia technique to provide effective postoperative analgesia by targeting the nerves of the anterior abdominal wall. This randomized controlled trial was conducted to evaluate the analgesic efficacy of transversus abdominis plane block in adult patients undergoing elective laparoscopic appendectomy.

Materials and Methods: In this prospective randomized study, 80 adult patients scheduled for elective laparoscopic appendectomy were randomly allocated into two groups. Group A received ultrasound-guided bilateral TAP block with 20 mL of 0.25% bupivacaine on each side at the end of surgery, while Group B received standard care without TAP block. Postoperative pain was assessed using the Visual Analog Scale (VAS) at 1, 4, 8, 12, and 24 hours. Total opioid consumption and incidence of opioid-related side effects were recorded.

Results: VAS scores at all postoperative intervals were significantly lower in Group A compared to Group B ($p<0.05$). The mean total opioid consumption in 24 hours was markedly reduced in the TAP block group. Additionally, the incidence of nausea, vomiting, and sedation was lower in Group A. No adverse effects related to TAP block were reported.

Conclusion: The use of transversus abdominis plane block provides superior postoperative analgesia, reduces opioid requirement, and minimizes opioid-related side effects in adult patients undergoing laparoscopic appendectomy. TAP block is a safe, effective, and valuable component of multimodal analgesia for enhanced recovery in minimally invasive abdominal surgery.

Keywords: TAP block, laparoscopic appendectomy, postoperative analgesia, randomized controlled trial, opioid-sparing, regional anesthesia.

INTRODUCTION

Acute appendicitis is one of the most common surgical emergencies worldwide, and laparoscopic appendectomy has now become the gold standard treatment due to its multiple advantages over open surgery, including smaller incisions, faster recovery, lower postoperative complications, and improved cosmetic outcomes.[1] However, despite being minimally invasive, patients undergoing laparoscopic appendectomy still experience significant postoperative pain, particularly in the early recovery period.[2] This pain arises not only from the surgical incisions but also from peritoneal irritation, visceral manipulation, CO_2 insufflation during pneumoperitoneum, and stretching of the abdominal wall.[3] Effective postoperative pain control remains a crucial component of enhanced

recovery protocols to improve patient satisfaction, facilitate early mobilization, reduce hospital stay, and prevent the development of chronic pain syndromes.[4]

Traditionally, systemic opioids have been the cornerstone of postoperative analgesia following laparoscopic appendectomy. While opioids are effective, their use is associated with several well-recognized adverse effects such as nausea, vomiting, sedation, respiratory depression, pruritus, constipation, and delayed recovery. These opioid-related side effects may hinder postoperative recovery, prolong hospitalization, and reduce overall patient satisfaction. Therefore, there has been a growing interest in developing opioid-sparing strategies that provide effective analgesia while minimizing systemic side effects.[5,6]

In recent years, regional anesthesia techniques have gained considerable attention as part of multimodal analgesia protocols to address postoperative pain more effectively. One such technique is the transversus abdominis plane (TAP) block, which targets the sensory nerves of the anterior abdominal wall located between the internal oblique and transversus abdominis muscles.[7] The TAP block effectively blocks the lower thoracic and upper lumbar nerves (T6 to L1), which contribute significantly to the somatic component of postoperative pain in abdominal surgeries. By selectively anesthetizing these nerves, TAP block can significantly reduce pain originating from surgical incisions and abdominal wall trauma without affecting visceral innervation or compromising systemic hemodynamics.[8]

The efficacy of TAP block has been extensively studied in various abdominal surgeries, including cesarean section, laparoscopic cholecystectomy, colorectal surgeries, and gynecological procedures. However, its role in laparoscopic appendectomy has been comparatively less explored, and available literature shows considerable variability in the reported outcomes. Differences in study designs, anesthetic agents, doses, timing of administration, and patient populations have contributed to inconsistent conclusions regarding its analgesic efficacy.[9,10]

Given these variations and the increasing demand for opioid-sparing pain management strategies in modern surgical practice, there remains a need for well-designed randomized controlled trials to evaluate the true efficacy of TAP block specifically in the context of laparoscopic appendectomy. Incorporating TAP block into routine practice for laparoscopic appendectomy has the potential to not only improve patient comfort but also reduce perioperative opioid consumption and associated adverse effects, thereby accelerating recovery and improving the overall surgical experience.

In light of these considerations, the present randomized controlled trial was conducted to assess the analgesic efficacy of ultrasound-guided transversus abdominis plane block in adult patients undergoing elective laparoscopic appendectomy. The primary objective was to evaluate postoperative pain scores at various time intervals, while secondary objectives included assessment of total opioid consumption, opioid-related side effects, and safety profile of the TAP block.

MATERIALS AND METHODS

This prospective randomized controlled trial was conducted over a period of 18 months in the Department of General Surgery at a tertiary care teaching hospital. The study included adult male and female patients scheduled to undergo elective laparoscopic appendectomy for uncomplicated acute appendicitis. Ethical clearance was obtained from the Institutional Ethics Committee prior to the commencement of the study, and written informed consent was obtained from all participants after explaining the study protocol, potential risks, and benefits.

The inclusion criteria for the study were adult patients aged between 18 and 60 years who were diagnosed with acute appendicitis on clinical examination and imaging, and who were scheduled for elective laparoscopic appendectomy under general anesthesia. Patients with complicated appendicitis (perforation, abscess, or generalized peritonitis), recurrent appendicitis, previous abdominal surgeries, bleeding disorders, allergy to local anesthetics, pregnancy, psychiatric illness, or refusal to participate were excluded from the study.

A total of 80 eligible patients were randomized into two equal groups (Group A and Group B) using computer-generated randomization sequences with sealed envelope allocation. Group A (TAP block group) received bilateral transversus abdominis plane block under ultrasound guidance following surgery, while Group B (control group) received standard care without TAP block. Both groups were comparable in terms of demographic profile, operative findings, and perioperative management.

All patients underwent standard general anesthesia using institutional protocols, which included induction with intravenous propofol, fentanyl, and muscle relaxants, followed by endotracheal intubation and maintenance with inhalational agents. Intraoperative analgesia was provided with a single standardized dose of fentanyl prior to incision. Pneumoperitoneum was established using CO_2 insufflation, and all laparoscopic appendectomies were performed using a standardized three-port technique by experienced surgeons.

At the end of surgery, patients in Group A received bilateral TAP block performed under strict aseptic precautions. The TAP block was administered using high-frequency linear ultrasound probe guidance to identify the fascial plane between the internal oblique and transversus abdominis muscles. A 22-gauge echogenic needle was advanced using the in-plane technique, and after careful negative aspiration, 20

mL of 0.25% bupivacaine was injected into each side of the abdominal wall. Group B did not receive any additional regional anesthesia technique.

Postoperative pain was assessed by trained nursing staff who were blinded to group allocation. Pain severity was recorded using the 10-point Visual Analog Scale (VAS), where 0 represented no pain and 10 represented the worst imaginable pain. VAS scores were documented at 1, 4, 8, 12, and 24 hours postoperatively. Rescue analgesia was provided in the form of intravenous morphine whenever the VAS score exceeded 4. The total opioid consumption over the first 24 hours was recorded for each patient. The incidence of opioid-related side effects such as nausea, vomiting, sedation, pruritus, and respiratory depression was also documented.

All data were collected prospectively and entered into a secured database for statistical analysis. Continuous variables such as age, weight, duration of surgery, VAS scores, and opioid consumption were expressed as mean ± standard deviation (SD), while categorical variables were expressed as frequency and percentage. Comparison of continuous variables between the two groups was performed using independent sample t-test or Mann-Whitney U test, as appropriate. Categorical variables were compared using the chi-square test or Fisher's exact test. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 80 adult patients undergoing elective laparoscopic appendectomy were enrolled and randomized into two equal groups of 40 patients each. Both groups were comparable in terms of demographic characteristics such as age, sex distribution, body mass index (BMI), and duration of surgery, ensuring homogeneity of study population. All patients successfully completed the study protocol without any protocol deviations or dropouts. No intraoperative complications or adverse effects related to TAP block were observed. The administration of transversus abdominis plane block resulted in significantly lower postoperative pain scores at all assessed time intervals compared to the control group. Total opioid consumption during the first 24 hours was significantly lower in the TAP block group. Additionally, the incidence of opioid-related side effects such as nausea, vomiting, and sedation was markedly reduced in patients receiving TAP block.

[Table 1] presents the comparison of baseline demographic data between the two groups.

Table 1: Demographic Characteristics of Study Population

Parameter	Group A (TAP Block)	Group B (Control)	p-value
Number of patients	40	40	—
Mean age (years)	34.6 ± 9.2	35.1 ± 8.8	0.78
Male (%)	25 (62.5%)	27 (67.5%)	0.64
Female (%)	15 (37.5%)	13 (32.5%)	0.64
Mean BMI (kg/m²)	24.7 ± 3.1	25.0 ± 2.9	0.61

[Table 2] shows intraoperative variables which were comparable between both groups.

Table 2: Intraoperative Parameters

Parameter	Group A	Group B	p-value
Mean surgery duration (minutes)	48.5 ± 7.2	49.3 ± 6.8	0.59
Intraoperative fentanyl (mcg)	100	100	—
Intraoperative complications	None	None	—

[Table 3] shows VAS pain scores recorded 1 hour postoperatively.

Table 3: Postoperative VAS Scores at 1 Hour

VAS Score (1 hr)	Group A (TAP)	Group B (Control)	p-value
Mean ± SD	2.4 ± 0.7	4.8 ± 1.0	<0.001

[Table 4] presents VAS scores at 4 hours postoperatively.

Table 4: Postoperative VAS Scores at 4 Hours

VAS Score (4 hr)	Group A (TAP)	Group B (Control)	p-value
Mean ± SD	2.8 ± 0.9	5.2 ± 1.1	<0.001

[Table 5] presents VAS scores at 8 hours postoperatively.

Table 5: Postoperative VAS Scores at 8 Hours

VAS Score (8 hr)	Group A (TAP)	Group B (Control)	p-value
Mean ± SD	3.1 ± 0.8	4.7 ± 1.0	<0.001

[Table 6] presents VAS scores at 12 hours postoperatively.

Table 6: Postoperative VAS Scores at 12 Hours

VAS Score (12 hr)	Group A (TAP)	Group B (Control)	p-value
Mean ± SD	2.5 ± 0.6	4.1 ± 1.0	<0.001

[Table 7] presents VAS scores at 24 hours postoperatively.

Table 7: Postoperative VAS Scores at 24 Hours

VAS Score (24 hr)	Group A (TAP)	Group B (Control)	p-value
Mean ± SD	1.7 ± 0.5	3.5 ± 0.8	<0.001

[Table 8] summarizes total opioid requirement in 24 hours.

Table 8: Total Opioid Consumption in 24 Hours

Total Morphine Consumption (mg)	Group A (TAP)	Group B (Control)	p-value
Mean ± SD	4.8 ± 1.3	10.6 ± 2.2	<0.001

[Table 9] shows opioid-related side effects observed in both groups.

Table 9: Incidence of Nausea and Vomiting

Side Effect	Group A (TAP)	Group B (Control)	p-value
Nausea (%)	4 (10%)	13 (32.5%)	0.02
Vomiting (%)	2 (5%)	9 (22.5%)	0.03

[Table 10] shows incidence of postoperative sedation.

Table 10: Incidence of Sedation

Sedation	Group A (TAP)	Group B (Control)	p-value
Present (%)	3 (7.5%)	12 (30%)	0.01

[Table 11] shows rare side effects recorded during postoperative period.

Table 11: Incidence of Pruritus and Respiratory Depression

Side Effect	Group A (TAP)	Group B (Control)	p-value
Pruritus (%)	1 (2.5%)	3 (7.5%)	0.30
Respiratory depression (%)	0 (0%)	1 (2.5%)	0.31

[Table 12] compares patient satisfaction based on postoperative pain control.

Table 12. Patient Satisfaction Score at 24 Hours

Satisfaction Score (0-10)	Group A (TAP)	Group B (Control)	p-value
Mean ± SD	9.1 ± 0.5	7.3 ± 0.8	<0.001

[Table 1] showed both groups were demographically comparable. [Table 2] confirmed that intraoperative parameters were uniform across both groups. [Tables 3 to 7] demonstrated significantly lower VAS scores at all time points in the TAP block group. [Table 8] revealed a marked reduction in total opioid consumption with TAP block. [Tables 9 and 11] demonstrated a significant reduction in nausea, vomiting, and sedation in the TAP block group with no serious adverse effects. [Table 12] showed significantly higher patient satisfaction scores in the TAP block group compared to the control group.

DISCUSSION

The present randomized controlled trial was designed to evaluate the analgesic efficacy of transversus abdominis plane (TAP) block in adult patients undergoing elective laparoscopic appendectomy. Postoperative pain, though less severe in minimally invasive procedures compared to open surgeries, remains a significant clinical concern following laparoscopic appendectomy.[11] Effective pain management is crucial not only for patient comfort but also for early ambulation, rapid recovery, reduced hospital stay, and overall improved surgical outcomes. Traditional reliance on systemic opioids for postoperative analgesia is associated with well-documented adverse effects that may delay recovery, prompting the ongoing search for opioid-sparing analgesic strategies.[12]

The transversus abdominis plane block has emerged as a promising regional anesthesia technique for abdominal surgeries due to its ability to block the afferent nerves supplying the anterior abdominal wall.[13] The somatic component of postoperative pain following laparoscopic appendectomy primarily arises from port site incisions, stretching of the abdominal wall, and manipulation of peritoneal surfaces during pneumoperitoneum. By targeting the lower thoracic and upper lumbar intercostal nerves (T6–L1), TAP block provides effective analgesia for

somatic pain, while having minimal impact on visceral innervation and systemic hemodynamics.[14,15]

The administration of ultrasound-guided TAP block significantly reduced postoperative pain scores at all assessed time intervals compared to patients who did not receive the block. The greatest benefit was observed during the first 24 hours postoperatively, which is consistent with the expected pharmacodynamic profile of single-shot local anesthetic blocks. These findings are clinically significant, as optimal pain control in the early postoperative period plays a vital role in minimizing patient discomfort, reducing stress response, and facilitating faster mobilization.[16]

The TAP block group also demonstrated a substantial reduction in total opioid consumption over the first 24 hours. This opioid-sparing effect is one of the most important advantages of incorporating TAP block into multimodal analgesia protocols. Reduced opioid requirement directly translates into a lower incidence of opioid-related side effects, as reflected by the significantly lower rates of nausea, vomiting, sedation, and respiratory complications observed in the TAP block group. These improvements contribute to higher patient satisfaction, enhanced recovery, and improved quality of care.[17]

Importantly, no adverse effects related to TAP block administration were observed in any patient in this study. The use of ultrasound guidance allowed precise identification of the fascial plane and accurate deposition of local anesthetic, minimizing the risk of complications such as vascular puncture, local anesthetic toxicity, or injury to adjacent structures. The safety and simplicity of the TAP block make it an attractive option even for routine use in day-to-day surgical practice.[18]

The findings of this study are consistent with several prior studies evaluating the analgesic efficacy of TAP block in other laparoscopic abdominal surgeries. The reproducibility of analgesic benefits across various surgical procedures reinforces the versatility and reliability of this regional anesthesia technique. Furthermore, the incorporation of TAP block aligns with modern enhanced recovery after surgery (ERAS) protocols, which emphasize multimodal, opioid-sparing pain management strategies to optimize postoperative outcomes.[19]

Despite the encouraging results, certain limitations of this study warrant acknowledgment. The duration of analgesia provided by a single-shot TAP block remains limited by the pharmacological half-life of local anesthetics. Continuous or catheter-based TAP blocks may provide prolonged analgesia but were not evaluated in this study. Additionally, the study focused primarily on adult patients undergoing uncomplicated laparoscopic appendectomy, and results may not be directly extrapolated to more complex or prolonged laparoscopic surgeries.[20]

Overall, this study strongly supports the use of TAP block as a safe, effective, and valuable component of multimodal analgesia for patients undergoing laparoscopic appendectomy. Incorporation of TAP block into routine perioperative care can significantly enhance patient comfort, reduce opioid burden, minimize opioid-related adverse effects, and contribute to faster recovery and higher patient satisfaction.

CONCLUSION

The present study demonstrates that transversus abdominis plane block provides superior postoperative analgesia in adult patients undergoing elective laparoscopic appendectomy. The block significantly reduces postoperative pain scores, lowers total opioid consumption, and minimizes opioid-related adverse effects such as nausea, vomiting, and sedation. The TAP block was found to be safe, well-tolerated, and easily administered under ultrasound guidance without any complications. Its incorporation into multimodal analgesia protocols enhances patient satisfaction and facilitates faster recovery following laparoscopic abdominal surgery. TAP block should be considered a valuable adjunct for optimal postoperative pain management in minimally invasive surgical procedures.

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