

# Evaluating Pain Management Strategies for Appendectomy: A Quasi-Experimental Study of Preincisional and Postoperative Bupivacaine Injection

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## ABSTRACT

**Objective:** This study evaluated the effectiveness of preincisional and postoperative bupivacaine injections in reducing pain after appendectomy.

**Methods:** This quasi-experimental study included 60 acute appendicitis patients undergoing appendectomy at Vajira Hospital. Participants were randomly assigned to three groups: group 1 received a preincisional 10-mL injection of 1% bupivacaine, group 2 received a postoperative 10-mL injection of 1% bupivacaine, and group 3 (control) received no bupivacaine. Postoperative pain was assessed using the Visual Analog Scale at 2, 6, 12, and 24-hour post-surgery. Complications, including wound hematoma and surgical site infections, were recorded.

**Results:** Pain scores were lower in both preincisional and postoperative bupivacaine groups compared to the control across all time points, with group 1 showing the greatest reduction. However, the differences in pain scores were not statistically significant. No complications, such as wound hematoma or surgical site infections, were observed, indicating bupivacaine's safety.

**Conclusions:** Preincisional and postoperative bupivacaine injections are effective and safe for reducing pain after appendectomy. Preincisional administration shows the best pain reduction and is a practical pain management option, especially in resource-limited settings.

**Keywords:** appendicitis, bupivacaine, hematoma, surgical wound infection, visual analog scale

## INTRODUCTION

Pain management is a cornerstone of Enhanced Recovery After Surgery (ERAS) protocols, designed to improve surgical outcomes and optimize patients' perioperative experience (1,2). The aims of ERAS protocols are to reduce surgical stress, maintain physiological function, and facilitate a faster return to normal activities (2,3). Effective pain control plays a central role in achieving these goals by directly improving multiple aspects of recovery, including early mobilization, reduced postoperative complications, and shorter hospitalization

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(3,4). Inadequate pain management can hinder recovery, leading to delayed mobilization, increased risk of complications such as thromboembolism, prolonged hospitalization, higher healthcare costs, and patient dissatisfaction (4). Therefore, optimizing perioperative pain management is essential not only for alleviating discomfort but also for promoting faster, more efficient recovery (5,6).

Postoperative pain results from a complex interaction of physical tissue damage and activation of pain pathways, which can lead to central sensitization, in which the nervous system becomes more responsive to pain signals (7,8). If not addressed, this heightened sensitivity can prolong pain and render its management more challenging (9,10). The principle of preemptive analgesia is that providing pain relief before the onset of surgical trauma can prevent or reduce central sensitization.<sup>9</sup> Preemptive analgesic delivery may blunt nociceptive input that would otherwise intensify pain perception during the postoperative period (11). This approach is a pain management strategy that is proactive instead of reactive and may potentially improve patient outcomes.

In comparison with more complex pain management strategies that necessitate advanced equipment or specialized techniques, local anesthetic injection is a simple, direct approach that surgeons can perform during the procedure (11,12). Wound infiltration with local anesthetics such as bupivacaine is minimally invasive and cost effective and does not necessitate additional resources (12). Because of this accessibility, this option is attractive to surgeons, especially in settings in which more sophisticated pain management tools may not be readily available (13). Moreover, local anesthetics administered at the surgical site can provide targeted pain relief without the systemic side effects associated with opioid analgesics (13,14).

The aim of this study was to compare the effectiveness of different timing strategies for administering bupivacaine in managing pain after appendectomy. Three strategies were evaluated: preincisional injection, postoperative wound infiltration, and no local anesthetic injection (control). With a focus on a straightforward, surgeon-administered technique, this study provides insights into a practical method for enhancing postoperative pain management; the findings have implications for surgical recovery practices, especially in resource-limited environments in which more elaborate pain control methods are not feasible (14).

The ultimate goal was to determine whether preemptive analgesia was distinctly more effective than postoperative administration and whether a simple

intervention such as local anesthetic injection could significantly improve patient comfort and recovery after surgery. The findings increase the evidence base for ERAS practices, potentially guiding clinical decision making to improve patient outcomes through more effective pain management strategies.

## MATERIAL AND METHODS

In this retrospective cohort study, conducted at Vajira Hospital, Bangkok, Thailand, preemptive and postoperative local analgesia were compared with no analgesia in managing postoperative pain among patients undergoing appendectomy.

### *Study Population*

The study included 60 patients with acute appendicitis who underwent appendectomy. The inclusion criteria were age of 18-60 years; diagnosis of acute appendicitis, confirmed clinically and intraoperatively; and elective or emergency appendectomy under general anesthesia. The exclusion criteria included the presence of chronic pain conditions, allergies to local anesthetics, prior abdominal surgery, or additional analgesic use outside the study protocol.

### *Study Groups*

Patients were randomly assigned to one of three groups:

- Group 1 received a 10-mL injection of 1% bupivacaine at the surgical site before the incision was made.
- Group 2 received a 10-mL injection of 1% bupivacaine at the surgical site immediately after wound closure.
- Group 3 (the control group) received no injection of a local anesthetic.

### *Surgical Procedure*

While patients were under general anesthesia, all appendectomies were performed by experienced surgeons with a standardized technique, and anesthesia was maintained through a combination of intravenous and inhaled agents.

### *Postoperative Pain Management*

Postoperative pain management was standardized across all groups according to a unified protocol. For

pain, patients received acetaminophen (paracetamol), 1 g every 6 h as needed; intravenous nonsteroidal anti-inflammatory drugs (NSAIDs) such as ketorolac, 30 mg every 8 h, were available for further pain control. Opioids, reserved for breakthrough pain that was unresponsive to the initial regimen, were administered only after a physician’s assessment. One aim of this protocol was to minimize opioid use while ensuring adequate pain relief for all patients.

*Pain Assessment*

To assess postoperative pain, patients used the Visual Analog Scale, wherein 0 indicated no pain and 10 indicated the worst pain. Pain scores were recorded 2, 6, 12, and 24 h after surgery. The mean pain scores for each group were compared.

*Data collection*

Data included demographic information, age, gender, and preoperative health status. The primary outcome was the mean postoperative pain score at each time point; the secondary outcome was the total amount of rescue analgesia required during the first 24 h after surgery.

*Ethical Considerations*

The study adhered to ethical standards for human research and was approved by the Vajira Hospital ethics committee. All patient data were anonymized to protect privacy.

*Statistical Analysis*

To analyze data, STATA version 16.0 was used. Values for continuous variables were calculated as means ± standard deviations, and those for categorical variables, as frequencies and percentages. To evaluate differences between the groups, analysis of variance or chi-square tests were used as appropriate; p values of <0.05 indicated significance.

**RESULTS**

Sixty patients with a diagnosis of acute appendicitis who underwent appendectomy participated in this study. All surgeries were completed successfully without postoperative complications, and baseline characteristics across the groups were similar, which indicated good comparability. The key baseline characteristics, including age, gender, and American Surgical Association classification, are listed in *table 1*.

*Pain Scores*

The primary outcome was postoperative pain, which was measured with the Visual Analog Scale 2, 6, 12, and 24 h after surgery. Across all time points, the mean pain scores were lowest after preincisional injection (group 1) and highest with no injections (group 3). The differences in pain scores between groups 1 and 3 were statistically significant at each time point; for patients receiving postoperative injection (group 2), reduction in pain was significantly better than that of group 3 only 2 and 6 h after surgery. These findings are summarized in *table 2*.

**Table 1 - Baseline characteristics of patients**

Characteristic	Group 1 (n = 20)	Group 2 (n = 20)	Group 3 (n = 20)	p-value
Mean age (years)	35.1 ± 10.2	34.5 ± 11.4	33.8 ± 9.7	0.783
Male, n (%)	12 (60%)	13 (65%)	11 (55%)	0.852
ASA Classification I/II	17/3	18/2	16/4	0.764

**Table 2 - Postoperative pain scores and wound complications**

Outcome	Group 1 (n = 20)	Group 2 (n = 20)	Group 3 (n = 20)	p-value
Mean pain score (2 hours)	3.1 ± 0.7	3.5 ± 0.8	5.6 ± 0.9	0.012
Mean pain score (6 hours)	2.8 ± 0.6	3.4 ± 0.7	5.5 ± 0.8	0.018
Mean pain score (12 hours)	2.4 ± 0.5	3.0 ± 0.6	5.1 ± 0.7	0.021
Mean pain score (24 hours)	2.0 ± 0.4	2.8 ± 0.5	4.7 ± 0.6	0.028
Wound hematoma, n (%)	0 (0%)	0 (0%)	0 (0%)	NA
SSI, n (%)	0 (0%)	0 (0%)	0 (0%)	NA

### *Early Postoperative Period (2 and 6 h)*

Two hours after surgery, group 1 had the lowest mean pain score ( $3.1 \pm 0.7$ ), which was significantly lower than that of group 3 ( $5.6 \pm 0.9$ ;  $p = 0.012$ ). Group 2 had a mean pain score of  $3.5 \pm 0.8$ , which was also significantly lower than that of group 3. This trend continued at 6 h: pain levels were lowest for group 1, intermediate for group 2, and highest for group 3.

### *Late Postoperative Period (12 and 24 h)*

Group 1 continued to report the lowest pain scores ( $2.4 \pm 0.5$  at 12 h and  $2.0 \pm 0.4$  at 24 h), which were significantly different from those of group 3 ( $5.1 \pm 0.7$  at 12 h and  $4.7 \pm 0.6$  at 24 h; both  $ps < 0.05$ ). Group 2 also had lower pain scores than did group 3 at these time points, but the differences were less pronounced.

### *Wound Complications*

No cases of wound hematoma or surgical site infections were observed in any patient, which indicates that local bupivacaine injections, whether preincisional or postoperative, did not increase the risk of wound-related complications.

## **DISCUSSION**

The findings suggest that preincisional bupivacaine injection provides more effective pain relief than does postoperative injection, and pain scores were significantly reduced throughout the first 24 h after surgery. The absence of wound complications indicates that both preincisional and postoperative bupivacaine injections are safe for patients undergoing appendectomy.

This study showed that preincisional and postoperative administration of bupivacaine injection resulted in lower postoperative pain scores than did no injection in patients undergoing appendectomy. Although some differences between groups 2 and 3 were not statistically significant, the trend suggests that the use of local anesthetic injections for postoperative pain management is beneficial, especially because of their ease of use and accessibility in the operating room setting. Of importance was that no complications related to wound hematoma or surgical site infections occurred in any patients, which is consistent with the existing literature in supporting the safety profile of local bupivacaine use in surgical procedures for pain control (2,15).

The efficacy of local anesthetic injection observed in this study is consistent with the goals of ERAS protocols, which emphasize multimodal analgesia and the reduction of opioid consumption after surgery (16,17). Effective pain management is crucial for optimizing patient outcomes because it reduces postoperative stress, enhances mobilization, and shortens hospitalization (18). Local anesthetic techniques such as bupivacaine injection are less technically demanding than options such as the transversus abdominis plane (TAP) block, which, although effective, necessitates ultrasound guidance and specialized skills that may not be readily available in all settings. In contrast, wound infiltration with bupivacaine, because of its simplicity, is a viable option for general surgical procedures, including appendectomy, for which more complex techniques may be unnecessary (2,6).

A comparison of this approach with TAP blocks reveals differences in analgesic efficacy and practicality. TAP blocks target the nerves supplying the anterior abdominal wall, providing broader coverage and often resulting in significantly less postoperative pain and fewer opioid requirements than does placebo or standard care (19-21). However, preincisional or postoperative bupivacaine injections, especially in resource-limited settings, are valuable alternatives that can be administered directly by the surgeon without additional equipment (14).

Epidural analgesia represents another highly effective but more invasive alternative often used in major abdominal surgeries. Through epidural injection, local anesthetics and opioids are delivered directly to the epidural space, which results in superior analgesia and reduces the incidence of postoperative complications such as ileus and thromboembolism. However, the associated risks, such as hypotension and urinary retention, particularly in patients receiving anticoagulation therapy, limit its application in minor procedures such as appendectomy. For procedures of this scale, wound infiltration remains a favorable choice because it is minimally invasive and safe (22).

In this context, intravenous analgesics, including NSAIDs and opioids, are commonly used to manage postoperative pain but often produce significant side effects. NSAIDs can cause gastrointestinal bleeding and renal impairment, and opioids are associated with nausea, vomiting, constipation, and the potential for dependency. In contrast, local bupivacaine infiltration provides targeted pain relief at the site of trauma, reducing the need for systemic analgesics and their associated risks, especially in patients sensitive to opioids or NSAIDs (23-27).

The results of this study suggest that preincisional bupivacaine injections may control pain better than does postoperative administration, which illustrates the concept of preemptive analgesia. The aim of preemptive analgesia is to mitigate central sensitization by administering anesthetic before the onset of nociceptive stimuli, which potentially reduces pain perception during the postoperative period. In this study, the trend toward lower pain scores with preincisional injections, although not significantly different from pain scores with postoperative injections, suggests that such interventions could contribute to better patient outcomes by reducing postoperative analgesic requirements and enhancing recovery (28-30).

One of the strengths of this study is the simplicity and accessibility of the technique: it does not require advanced skills or equipment, and thus its use is generalizable across a variety of surgical settings. Moreover, no complications related to bupivacaine injections occurred, which indicated the safety of the technique for use in appendectomies. However, the small sample size may limit the study's power to detect significant differences between the groups; this possibility highlights the need for larger trials to validate these findings. In addition, this investigation was a single-center study, which may limit the generalizability of the results to other settings with different surgical practices or patient populations.

Future research should include larger, multicenter trials to confirm these findings and to compare the effectiveness of local anesthetic infiltration with that of other techniques for inducing regional anesthesia, such as TAP blocks, for different surgical procedures. Investigation of long-term outcomes related to chronic pain development and patient satisfaction could provide further insights into the benefits of preemptive analgesia and its role within ERAS protocols. The valuable data provided by this study augments the existing evidence of the safety and feasibility of using bupivacaine injections for postoperative pain management, especially in resource-limited environments, in which straightforward and effective solutions are needed to improve patient outcomes.

## CONCLUSIONS

This study revealed that patients undergoing appendectomy who received either preincisional or postoperative wound infiltration with bupivacaine experienced less postoperative pain than did those who received no injection, although some differences were not statistically significant, and no serious post-

operative complications occurred. These findings highlight the safety and practicality of local anesthetic injections for pain management and support their integration into surgical practice, especially in settings in which advanced pain management resources may be limited. More complicated techniques such as TAP block may provide broader pain relief; however, local infiltration, because of its simplicity and minimal risk profile, is a valuable component among the multimodal pain management strategies advocated by ERAS protocols.

## Data Statement

The data used in this study were collected from anonymized medical records and are not publicly available due to confidentiality and privacy regulations. Access to the data is restricted to authorized personnel in compliance with ethical standards.

## Conflict of Interest

Chakrawan Sangkaprom and Suphakarn Techapongsatorn have no conflict of interest.

## Funding Statement

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