

Comparison of Post-Operative Pain Scores with Instillation of 0.25% Bupivacaine VS 0.50% Bupivacaine Intra-operatively in the Inguinal Canal for Inguinal Hernia Repair

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ABSTRACT

Objective: To compare the effect of 0.25% versus 0.50% bupivacaine wound instillation on post-operative pain intensity following elective open inguinal hernia repair.

Methodology: This prospective comparative interventional research was done within the Department of General Surgery, Mayo Hospital, Lahore, in a period of over six months. Sixty male patients aged over 18 and having an elective open inguinal hernia repair under spinal anesthesia were recruited through non-probability consecutive sampling and divided into two groups. Group A was instilled with 0.25 percent bupivacaine and Group B with 0.50 percent bupivacaine on the wound. The Numerical Pain Rating Scale was used to measure post-operative pains at 8 hours. Analysis of the data involved the use of IBM SPSS version 24 and proper analysis involved independent samples t-test and Chi-square test.

Results: Baseline characteristics were comparable between the two groups ($p > 0.05$). Mean post-operative pain score at 8 hours was significantly lower in Group B compared to Group A (1.23 ± 0.42 vs 2.58 ± 0.54 ; $p < 0.001$).

Conclusion: Wound instillation with 0.50% bupivacaine provides superior early post-operative pain control compared to 0.25% bupivacaine following open inguinal hernia repair and may be considered a practical option for improving immediate post-operative analgesia.

Keywords: Inguinal hernia, bupivacaine, wound instillation, post-operative pain, analgesia

Introduction

One of the most common general surgical procedures that are carried out globally is inguinal hernia repair. Post-operative pain in open inguinal hernia repair remains a problem despite improved surgical procedures especially in the initial phase of recovery. Poor pain management can affect ambulation, extend hospitalization and the need of rescue analgesics.¹

The use of multimodal analgesia has been strongly promoted to decrease pain after surgery in conjunction with the reduction of adverse effects of opioids. Local anesthetic wound instillation is one of the strategies that is easy to implement in surgical practice due to its simplicity, low cost, and simple inclusion in routine surgical practice.² The prolonged action and good safety profile of bupivacaine are the reasons why this drug is widely employed.

In recent years, increasing emphasis has been placed on enhancing early post-operative recovery pathways, particularly through strategies that minimize pain while reducing reliance on systemic opioids. Effective early

pain control not only improves patient comfort but also facilitates early ambulation, reduces hospital stay, and lowers the risk of complications such as deep vein thrombosis and pulmonary issues. Inguinal hernia repair, being a high-volume procedure, provides an ideal model for evaluating simple, cost-effective analgesic interventions that can be easily integrated into routine surgical practice. Therefore, optimizing local anesthetic techniques remains a clinically relevant and practical goal in modern perioperative care.³

Furthermore, variability in clinical outcomes associated with different concentrations of local anesthetics has led to ongoing debate regarding the balance between efficacy and safety. While higher concentrations of bupivacaine may provide more profound and prolonged analgesia, concerns regarding potential systemic toxicity and local tissue effects persist. Conversely, lower concentrations may be safer but could compromise analgesic effectiveness.

This uncertainty highlights the need for well-designed comparative studies to determine the most appropriate concentration that ensures optimal pain relief without increasing adverse effects. Addressing this gap is essential for establishing standardized analgesic protocols in inguinal hernia surgery.⁴

Despite the popularity of bupivacaine wound instillation, there remains a lack of agreement on the optimum concentration of bupivacaine needed to provide effective analgesia without complicating the adverse effects. Reduced concentrations can be harboring inadequate analgesic effects and increased concentrations can be of long-term analgesic effect but can be associated with safety and systemic uptake.⁵

The present study was designed to compare the analgesic efficacy of 0.25% and 0.50% bupivacaine wound instillation in patients undergoing open inguinal hernia repair. This study will use evidence to make recommendations and therefore propose the best local anesthetic concentration to enhance patient comfort and recovery by emphasizing on the results of early post-operative pain.

Methodology

This was a prospective comparative interventional study conducted at the Department of General Surgery, Mayo Hospital, Lahore. This study was conducted in the operating rooms and the post-operative surgical wards upon receiving the approval of the Institutional Review Board. The study took a total of six months, between September 15, 2024 and 15 March 2025. Throughout the research, ethical principles were followed. Before enrollment, all participants had to give written consent. Data confidentiality and anonymity of patients were maintained as per Helsinki declaration. The Research Evaluation Unit (Ref No: CPSP/REU/SGR-2023-066-15290, dated September 15, 2024) of College of Physicians and Surgeons Pakistan (CPSP) approved the study.

Male patients with a history of elective open inguinal hernia repair under spinal anesthesia between the age groups of 18 and 75 years were eligible to be included. Enrolment was made of patients who had unilateral direct or indirect inguinal hernia scheduled to undergo mesh repair. The patients were not included in patients with ASA physical status of IV or V, uncontrolled diabetes mellitus, known peripheral neuropathy, taking neuropathic pain medication, previous inguinal hernia surgery on the same side, bilateral inguinal hernia, laparoscopic repair, or surgery under general or local anesthesia.

The sampling method used was a non-probability consecutive sampling technique. All potential patients who were available within the study duration were

recruited until the expected sample size had been reached. A total of 60 patients were included in the study, with 30 patients allocated to each intervention group. The sample size was calculated using a 95% confidence interval and 80% power of test, based on previously reported differences in post-operative pain scores between patients receiving 0.25% and 0.50% bupivacaine in inguinal hernia repair.^{1, 2}

The participants were then assigned into two groups of intervention based on a predetermined sequence of allocation prepared by an independent statistician after enrolling them. Allocation was done on sealed opaque envelopes which were opened during the operation. The concentration of bupivacaine was not given to the patients. Group A was wound instilled with 0.25% bupivacaine and Group B with wound instilled with 0.50% bupivacaine.

The surgeries were all done using a standardized open inguinal hernia repair with spinal anesthesia. The inguinal canal was bathed with the study solution after incision of the external oblique aponeurosis and before dissection of the spermatic cord. In Group A, the solution was 50 ml of normal saline with 20 ml 0.25% bupivacaine at the dosage of 2mg/kg and 4mg/kg dexamethasone. Group B was treated with the same volume of normal saline combined with 20 ml of 0.50% bupivacaine 2mg/kg and 4mg dexamethasone. Five minutes were given to the solution to be there in the inguinal canal then the surplus fluid was cleared with the help of abdominal sponges.

By the end of the process, 10 ml of 2% lignocaine was given to all patients as a subcutaneous injection in the area of the wound. The following analgesia was standardized to all patients after the surgery; intravenous paracetamol 1 gram every four hours and intravenous reality ketorolac 30mg every eight hours.

The main study outcome was the intensity of post-operative pain measured using the Numerical pain Rating Scale. The pain level was measured eight hours after surgery, and the score was on a scale of 0, which meant that there was no pain and 10, which meant that the pain was the worst a person could ever imagine. The same researcher conducted pain assessment to create uniformity. Other health data gathered were in terms of age, body mass index, ASA status, side of hernia and time taken to operate.

The statistical analysis and data entry were conducted using the IBM SPSS Statistics version 24. Continuous variables were tested on normality by the use of Shapiro-Wilk test. Quantitative data was presented as a mean value with standard deviation whereas qualitative data used frequencies and percentages to express the variable. The independent samples t-test

was used to compare the mean pain scores in the two groups. Age, body mass index, ASA status, side of hernia and operative time were stratified and compared with the independent t-test after stratification. The p-value of 0.05 was taken to be statistically significant.

Results

Normality of continuous variables was assessed using Shapiro-Wilk test, which were suitable for parametric analysis. The average age, BMI and operation time were similar amongst both the groups. The independent samples t-test did not reveal any significant difference of baseline characteristics of Group A and Group B. ($p > 0.05$).

Clinical characteristics of Group A and Group B were comparable. ASA status ($p = 0.066$), side of hernia ($p = 0.474$) and type of hernia ($p = 0.600$) were not statistically different between groups. These findings suggest that the two groups were well equivalent at baseline. Thus these variables were unlikely to confound.

Shapiro-Wilk test was used to check for normality of pain scores. The post-operative pain score in the first 8 hours was significantly lower when 0.50% bupivacaine was utilized in place of 0.25%. The two groups significantly differed from each other as shown by an Independent samples t-test ($p < 0.001$).

Scatter graph illustrates how post-operative pain scores were distributed at 8 hours in patients who received

either 0.25% or 0.50% bupivacaine for intra-operative instillation while undergoing open inguinal hernia repair. Each point represents a unique patient's data. In comparison to the 0.25% bupivacaine group, the 0.50% bupivacaine group exhibited a demonstrably lower pain score (independent samples t-test, $p < 0.001$).

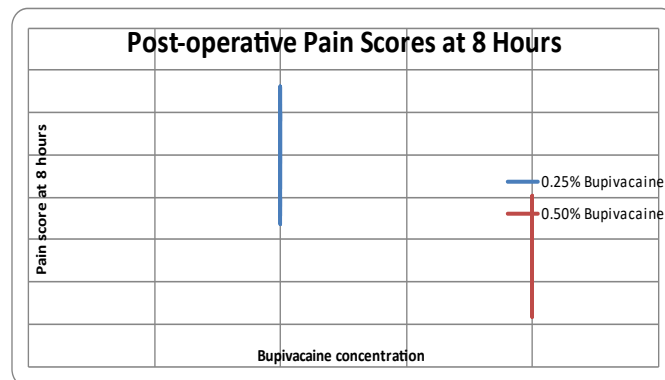


Figure 1. Post-operative pain scores at 8 hours according to bupivacaine concentration.

Discussion

The pain that follows open inguinal hernia surgery is a clinical concern as insufficient analgesic treatment slows down movement and escalates further analgesic treatment. The baseline characteristics in the present work were similar between the two groups. Therefore, the significant difference in pain scores at 8 hours can be attributed to the analgesic strategy and not differences in age, BMI, operative time, and clinical profile. Lower pain scores in the higher concentration

Table I: Baseline Characteristics of Study Participants.

Variable	Group A (0.25% Bupivacaine) Mean $\pm$ SD (n=30)	Group B (0.50% Bupivacaine) Mean $\pm$ SD (n=30)	Mean difference (95% CI)	p-value
Age (years)	43.5 $\pm$ 16.7	40.6 $\pm$ 15.8	2.9 (−5.5 to 11.3)	0.492
Body mass index (kg/m ²)	26.4 $\pm$ 2.3	26.0 $\pm$ 2.4	0.47 (−0.76 to 1.69)	0.449
Operative time (minutes)	55.0 $\pm$ 9.7	52.7 $\pm$ 10.9	2.3 (−3.0 to 7.6)	0.390

Table II: Distribution of Clinical Characteristics Between Study Groups.

Variable	Category	Group A n (%)	Group B n (%)	χ^2 (df)	p-value
ASA status	I	10 (33.3)	11 (36.7)	0.091 (2)	0.955
	II	8 (26.7)	8 (26.7)		
	III	12 (40.0)	11 (36.7)		
Side of hernia	Right	18 (60.0)	12 (40.0)	2.400 (1)	0.121
	Left	12 (40.0)	18 (60.0)		
Type of hernia	Direct	14 (46.7)	13 (43.3)	0.067 (1)	0.795
	Indirect	16 (53.3)	17 (56.7)		

Table III: Comparison of Post-Operative Pain Scores at 8 Hours.

Variable	Group A (0.25% Bupivacaine) Mean $\pm$ SD (n=30)	Group B (0.50% Bupivacaine) Mean $\pm$ SD (n=30)	Mean difference (95% CI)	p-value
Pain score at 8 hours	2.58 $\pm$ 0.54	1.23 $\pm$ 0.42	1.36 (1.11–1.61)	<0.001

bupivacaine group are in line with a wider body of evidence that higher intensity or longer exposure to local anesthesia at the site of surgery improves early post-operative comfort, especially during peak pain time.

The current data still show that local anesthetic-based approaches remain effective interventions of multimodal analgesia in surgery of inguinal hernia. An increasing literature has been dedicated to regional methods (e.g., TAP block or ilioinguinal/iliohypogastric blocks) and shows a consistent decrease in pain and/or opioid needs following inguinal hernia repair.^{3, 4} A meta-analysis of TAP block in inguinal hernia repair showed better post-operative pain, and less opioid consumption, which supports the importance of local-regional methods in the use of early analgesia.⁵ Simultaneously, randomized/controlled comparisons of the various TAP block dosing regimens also indicate that efficient analgesia may be attained without having to necessarily utilize extremely high concentrations when volume and technique are maximized.⁶ These findings provide a supportive context for the present results, where a stronger local anesthetic concentration was associated with lower early pain scores.

The accordance of adjuvants with local anesthetic analgesia duration or strength is a viable clinical issue, especially in resource-limited areas where decreasing opioid exposure is desirable. The research on inguinal hernia related regional anesthesia has provided evidence that perioperative use of dexamethasone combined with the bupivacaine in TAP block can extend analgesia and enhance early pain profiles, but dose-response variations can be insignificant.⁷⁻⁹ Extensive perioperative data also substantiate the use of adjuvants like dexmedetomidine or dexamethasone in regional methods to increase the analgesic rate and decrease additional analgesic demand.¹⁰ Although the current study implemented dexamethasone on both sides (that is, it was not intended to assess the independent effect of dexamethasone, hence), the overall evidence pattern indicates that the combination of local anesthetic with adjuvant interventions may have a significant impact on the initial pain results.

The biological plausibility of enhanced early pain control with greater exposure of local areas to local anesthetic has also been reinforced through newer delivery systems aimed at extending local anesthetic effect. Investigation of bupivacaine implants (Xaracoll/INL-001) in open inguinal repair demonstrates that in terms of pain and/or opioid use, both clinical appraisal and safety/pharmacokinetic research can be equivalent to the most painful period following surgical intervention.¹¹⁻¹³ These data are compatible with the current results since they can suggest the idea that better or more prolonged presence of local anesthetics on the operation

site enhances immediate analgesia despite the fact that the route of delivery is different.

Moreover, some recent comparative researches in hernia-related population give encouraging indications that local anesthetic methods are still competitive against other infiltrative agents or methods. A recent comparison between pre-operative infiltration regimens in Lichtenstein repair established significant differences in the outcome of pain between agents of infiltration, with the decision-making and prescription of local analgesia reported to manifest as visibly different pain results in the early post-operative period.¹⁴⁻¹⁶

Other more current studies in the pediatric and adult hernia environment contrasting wound infiltration with other techniques also serve the same purpose of confirming that local anesthetic-based approaches to provide temporal predictability can provide early analgesia in the context of standardized post-operative programs.⁷⁻¹⁹

Combined, the results of the study substantially reduce the pain level at 8 hours with the higher-concentration bupivacaine regimen aligns with the present-day trend of evidence-based information regarding intensified local-regional analgesia use during the repair of inguinal hernias. The clinical implication is easy to understand: better pain management early in its development could be beneficial in the immediate post-operative period as early as mobilization occurs and analgesic needs are at their highest point. External validity can be enhanced in future studies by including serial pain time-points (e.g., 2, 4, 12, 24 hours), monitoring rescue analgesic intake, and adverse events and long-term outcomes including long-lasting post-herniorrhaphy pain.

Limitations: The study was carried out in one tertiary care center; hence, the researcher might not be able to generalize the results to other clinical environments. The measurement of pain was at one post-operative time (8 hours) and thus the effects of changes in pain intensity over an extended duration were not possible. Moreover, standardized surgery and analgesic guidelines might not support the power of causation due to a non-probability consecutive sampling method and comparatively small sample size.

Recommendations: Multicenter designs are suggested in future research with larger sample size to enhance external validity. To have a more in-depth analysis of the analgesic efficacy, the pain at various time points following the operation and records of the analgesic needs and patient satisfaction would be evaluated. It is also suggested that comparative research should be

carried out in an effort to maximize the use of local anesthetic agents, concentrations and adjuvant combinations in the attempt to manage post-operative pain in inguinal hernia surgery.

Conclusion

Wound instillation with 0.50% bupivacaine provided significantly better post-operative pain control at 8 hours compared to 0.25% bupivacaine in patients undergoing open inguinal hernia repair. The two groups

were comparable in baseline characteristics, supporting the observed difference as a true treatment effect. Higher-concentration bupivacaine may therefore be considered an effective and practical option for improving early post-operative analgesia following open inguinal hernia repair.

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