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Incidence and Predictors of Rebound Pain Following Peripheral Nerve Block Among Orthopedics Surgical Patients

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ABSTRACT

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Declaration:

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BMA: Conceptualization, study design, data collection, analysis, interpretation and manuscript preparation; AAO: Supervision, study design, interpretation, and critical review. Both authors approved the final manuscript.

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Background: Rebound pain is an underestimated postoperative complication, characterized by severe pain after the resolution of the block. Although PNBs are increasingly utilized in orthopedic surgery, data regarding rebound pain incidence and predictors is scarce, especially in low-resource settings.

Aim: The study aimed to assess the incidence and predictors of rebound pain among adults who underwent orthopedic surgeries of the upper extremities under peripheral nerve block in Ethiopia, 2025/2026.

Methods: A prospective cohort study was conducted among 200 adult patients who underwent orthopedic surgery with peripheral nerve block. Patients were monitored for 48 hours after surgery, and data collection was done through structured questionnaires and chart reviews. Pain intensity was measured using the Numeric Rating Scale after the sensory block resolution. Rebound pain assessed at 12–24 hours post-block resolution. Multivariable logistic regression was performed to identify independent predictors, with statistical significance at $p < 0.05$.

Results: The incidence of rebound pain was found to be 88/200(44.5%). Dexamethasone pre-medication and Intraoperative analgesia were independently associated with lower odds of rebound pain (AOR = 0.18; 95% CI: 0.04-0.92) and (AOR = 0.39; 95% CI: 0.16-0.96), respectively, while NLR ≥ 3 was independently associated with higher odds of rebound pain (AOR = 8.20; 95% CI: 3.71-18.31).

Conclusion: Rebound pain was prevalent following PNB after orthopedic surgeries of the upper extremities. Intraoperative analgesia and dexamethasone premedication have a protective effect against rebound pain while higher NLR levels are risk factors for the development of rebound pain. These results advocate for further investigation into multimodal analgesic approaches and inflammatory risk indicators in perioperative pain management.

Keywords: Analgesia, Dexamethasone, incidence, Nerve block, Pain, Risk factors

INTRODUCTION

Pain is a major global health problem involving disability, decreased quality of life, and significant socio-economic costs to society, making it a public health priority (1, 2). WHO considers proper pain management to be an essential part of healthcare and one of the basic rights of humans (3). Post-surgical pain management is challenging and, even when adequately treated, can be a risk factor for morbidity (1-4). 41% of people suffer from post-surgical pain, among orthopedic surgeries, the incidence is highest (5,6,7). Post-surgical pain that is improperly treated can lead to delayed healing, increased length of hospitalization, morbidity, and the development of chronic post-surgical pain (8,9,10). Peripheral nerve blocks (PNBs) are effective procedures for post-operative analgesia, which are frequently applied as part of multimodal analgesia and play an integral role in procedures such as arthroscopic rotator cuff repair (11). PNBs can assist with reducing opioid use and accelerating post-operative recovery and patient satisfaction (12-15).

However, despite the analgesia that PNBs provide, pain can increase substantially following the resolution of the block (11). Specifically, single-shot PNBs can be followed by rebound pain, which is a severe pain occurring after the resolution of anesthesia which may be greater than the initial post-operative pain (15,16). Rebound pain occurs in about half the people on whom PNB is given and is especially prevalent in ambulatory orthopedic surgery (18,19). The mechanism by which it occurs is not entirely understood, although several theories have been postulated, including abrupt restoration of nociceptive inputs, peripheral and central sensitization, and inflammatory hyperalgesia (20,21). The severity of rebound pain may be influenced by a range of patient- and surgery-related factors (17,20,21). Moreover, lack of transitional analgesia and systemic inflammatory response can also worsen the severity of rebound pain (20,22). Therefore, the phenomenon of rebound pain can be seen as an important limitation of single-shot peripheral nerve blocks despite their effective analgesic properties (16,23,24).

Clinically, rebound pain can have a negative impact on post-operative outcomes by adversely affecting recovery and increasing the requirement for rescue opioids (17,18). As such, there has been a growing interest for strategies to counter rebound pain. Preventive strategies include multimodal analgesia, adjuvants, early oral analgesia before the resolution of the block, and continuous peripheral nerve block catheters (20,21,25). The Gate Control Theory of Pain provides an informative conceptual basis for understanding rebound pain after resolution of a nerve block, postulating that the transmission of nociceptive signals is modulated in the spinal cord, and alterations of this modulation can underlie enhanced pain after the resolution of a block (17,20,26). Despite the increasing appreciation of the phenomenon of rebound pain, the evidence for its incidence and predictors is limited. This is especially true for low-income settings such as Ethiopia, where data on rebound pain are scarce. Moreover, the role of the systemic inflammatory response in rebound pain is poorly characterized. Inflammatory biomarkers, specifically the neutrophil-to-lymphocyte ratio (NLR), may have promising prognostic implications in rebound pain (27,28).

Therefore, this study examines the incidence and predictors of rebound pain in Ethiopian tertiary hospitals. By providing the much-needed evidence on the incidence and outcomes of rebound pain in this low-income setting and evaluating potential predictors, including the inflammatory biomarker NLR, the study contributes to the generation of context-specific and optimal strategies for the prevention and management of rebound pain.

Aim

The study aims to assess the incidence and predictors of rebound pain following peripheral nerve block in adult patients undergoing upper extremity orthopedic surgery at Tibebe Ghion Specialized Hospital in Ethiopia during 2025/2026.

Objectives

To assess the incidence of rebound pain following peripheral nerve block among adult upper extremity orthopedic surgical patients at Tibebe Ghion Specialized Hospital, Ethiopia, 2025/2026

To identify patient-related, surgical, and anesthesia-related factors associated with rebound pain among adult upper extremity orthopedic surgical patients at Tibebe Ghion Specialized Hospital, Ethiopia, 2025/2026

METHODS

Study Design and Period

A prospective cohort study involving two hundred orthopedic patients was conducted from December 2025 to July 2026 to determine factors related to rebound pain following peripheral nerve block anesthesia (PNB).

Study Setting

The study was conducted at Tibebe Ghion Specialized Hospital, a tertiary teaching and referral hospital, associated with Bahir Dar University found in Bahir Dar, northwest Ethiopia. The hospital has a wide range of orthopedic surgical procedures and utilizes peripheral nerve block as one of its anesthetic procedures.

Study Population

Adult patients underwent orthopedic surgical procedures under the peripheral nerve block at Tibebe Ghion Specialized Hospital during data collection period.

Eligibility Criteria

Adult patients aged 18 years and older who underwent orthopedic surgery with PNB and provided informed consent to participate were included in the study. Patients who could not communicate or express their level of pain, those converted to general anesthesia during the procedure, and those with neurological conditions that might interfere with pain sensation were excluded from the study.

Sample Size Determination and sampling technique

The sample size for the study was calculated, using a single-population proportion formula with an expected proportion of 70.9% (28). Using a 95% confidence level and a 5% margin of error, the initial sample size was determined to be 316. Considering the accessible population of approximately 200 patients undergoing orthopedic surgery, a finite population correction (FPC) was applied, resulting in a final sample size of 123. To optimize precision, all 200 eligible patients were consecutively recruited, and included in the final analysis.

Operational Definitions

Rebound pain is severe post-operative pain (measured by NRS 7/10) that occurs peripherally in the 12–24 hours after resolution of the sensory block, revealed by the return of sensation to the patient's skin following peripheral nerve block (18).

The rebound pain score was calculated as the difference between the maximum pain score on the first 12 hours since resolution of the peripheral nerve block and the minimum pain score measured during the 12 hours preceding block resolution (23).

Data Collection Tools

A standardized questionnaire and clinical checklist were used to collect data on clinical and sociodemographic factors, intraoperative information, anaesthetic methods, analgesic use, and laboratory markers such the neutrophil-to-lymphocyte ratio. A standardized numerical rating scale (NRS) was used to assess pain severity.

Validity and Reliability Assurance

To guarantee clarity and consistency, the data collecting questionnaire which was modified from previous studies and validated by an expert in the anesthesia department through a four-day descriptive pilot trial with three patients. A four-

day pilot study was conducted to assess the clarity, applicability, and consistency of the questionnaire. Prior to the primary data collection, adjustments were made.

Data Collection Procedure

Data were collected during the perioperative period, including preoperative data, intraoperative variables, and postoperative pain assessments at set intervals after nerve block resolution, with trained data collectors ensuring accuracy and consistency

Data Processing and Statistical Analysis

Data were analyzed using SPSS version 20 with both descriptive and inferential statistics. Continuous variable distributions were assessed through skewness and kurtosis, while categorical variables were summarized via frequencies and percentages. Means and standard deviations described continuous variables that were normally distributed. Categorical bivariable comparisons utilized Pearson's chi-square test. Binary logistic regression identified factors related to rebound pain, considering variables with $p < 0.25$ from bivariable analysis and clinically relevant factors for multivariable logistic regression. Crude and adjusted odds ratios (CORs and AORs) with 95% confidence intervals were presented, with statistical significance at $p < 0.05$. An available-case analysis was performed for missing data, and model fit was evaluated using the Hosmer–Lemeshow test ($\chi^2 = 6.91$, $p = 0.54$). Multicollinearity analysis included VIF and tolerance statistics, revealing a maximum VIF of 4.69 and a minimum tolerance of 0.21.

Ethics approval and consent to participate

Ethical approval was obtained from TORG-IRB (reference number TORG-IRB-20260227-02). Written informed consent was obtained from each participant. The confidentiality of the information provided was ensured, as all details were kept strictly confidential and were used only by the researchers. In addition, each participant could withdraw from the study without suffering any negative consequences. There were no financial temptations for those participating in the research. Finally, the study did not involve any significant risks to the participants' health, as it only included routine treatment observation and regular pain assessments. All data collected were secured and available only to the researchers.

RESULTS

Socio-Demographic and Preoperative Clinical Characteristics

Among 200 study patients, 71.5% were male, and 54.0% had a BMI of 18.5–24.9 kg/m². Most patients classified as ASA I–II, with 29.0% having at least one coexisting medical condition. Preoperative complete blood count testing was performed on 91.5% of participants. Detailed characteristics are shown in Table 1.

Table 1. Socio-Demographic and Preoperative Clinical Characteristics of Participants (N = 200)

Variable	Category	Frequency (n)	Percentage (%)
Sex	Male	143	71.5
	Female	57	28.5
Body mass index (kg/m ²)	18.5–24.9	108	54.0
	>24.9	92	46.0
ASA physical status	ASA I	26	13.0
	ASA II	105	52.5
	ASA ≥III	69	34.5
Coexisting disease	Yes	58	29.0
	No	142	71.0
Type of coexisting disease(n=58)	Diabetes mellitus	11	18.9
	Hypertension	19	32.8
	Asthma	6	10.3

Complete blood count performed	Epilepsy	6	10.3
	Heart disease	5	8.6
	Anemia	11	18.9
	Yes	183	91.5
Neutrophil-to-lymphocyte ratio	No	17	8.5
	<3	113	56.5
Preoperative pain	≥3	87	43.5
	Yes	92	46.0
Preoperative analgesia received	No	108	54.0
	Yes	79	39.5
Type of preoperative analgesia	No	121	60.5
	Opioids	43	54.4
	NSAIDs	34	43.0
	Paracetamol	39	49.4

Footnote: PCM; paracetamol, NSAIDs; non-steroidal anti-inflammatory drugs, HD; Heart Disease, DM ;Diabetes mellitus, HTN; Hypertension, percentages for specific comorbidities were calculated among patients with coexisting disease(n=58), BMI; Body mass index, ASA; American Society of Anesthesiologists, in analgesic categories multiple responses were permitted and percentage calculated among the 79 patients who received preoperative analgesia.

Operative Characteristics

Bone surgery comprised 54.5% of the procedures. Tourniquet duration data was available for 76 out of 119 patients who underwent a tourniquet. Analyses that required tourniquet duration considered only cases with available data as shown in Table 2.

Table 2. Operative Characteristics (N = 200)

Variable	Category	Frequency (n)	Percentage (%)
Urgency of the procedure	Elective	106	53.0
	Emergency	94	47.0
Type of Surgery	Bone	109	54.5
	Soft Tissue	91	45.5
Tourniquet Use	Yes	119	59.5
	No	81	40.5
Duration of Tourniquet (n=76)	Below Mean(67.48min)	39	19.5
	Above Mean(67.48min)	37	18.5
Surgical Procedure	Fixation	47	23.5
	Plating	13	6.5
	D&I	58	29.0
	Removal	28	14.0
	Amputation	4	2.0
	Skin graft	13	6.5
	Pinning	16	8.0

Footnote: D&I; Irrigation and Debridement, tourniquet duration available, n=76/119

Peripheral Nerve Block and Anesthetic Characteristics

Supraclavicular block was the most frequently utilized peripheral nerve block, accounting for 46.5% of cases. Bupivacaine was administered to 165 patients (82.5%). Out of 111 patients receiving an adjuvant, the type was recorded for 85, with 26 lacking this information. Analyses involving adjuvant types were based on available cases, with detailed characteristics provided in Table 3.

Table 3. Peripheral Nerve Block and Anesthetic Characteristics (N = 200)

Variable	Category	Frequency (n)	Percentage (%)
Type of Peripheral Nerve Block	Interscalene	3	1.5
	Supraclavicular	93	46.5
	Axillary	92	46.0
	Wrist	12	6.0
Local Anesthetic Type	Bupivacaine	165	82.5
	Lidocaine	35	17.5
Adjuvant Used	Yes	111	55.5
	No	89	44.5
Type of Adjuvant(n=85)	Dexamethasone	64	32.0
	Opioid	21	10.5
Dexamethasone Premedication	Yes	109	54.5
	No	91	45.5
Intraoperative Analgesia Received	Yes	108	54.0
	No	92	46.0

Footnote: although 111 patients received adjuvants, 26 data's missed adjuvant type records

Postoperative Outcomes and Block Characteristics

Postoperative opioid analgesics were given to 50% of patients. After the sensory block resolved, 70.5% reported moderate-to-severe pain. The mean duration of sensory block was 10.05 hours, with a mean time to block resolution of 15.44 hours (Table 4).

Table 4. Postoperative Outcomes and Block-Related Characteristics (N = 200)

Variable	Category	Frequency (n)	Percentage (%)
Postoperative Opioid Use	Yes	100	50.0
	No	100	50.0
Postoperative NSAID Use	Yes	108	54.0
	No	92	46.0
Postoperative Paracetamol Use	Yes	106	53.0
	No	94	47.0
Severity of Pain After Block Resolution	No pain	3	1.5
	Mild Pain	56	28.0
	Moderate pain	52	26.0
	Severe Pain	89	44.5
Rebound Pain	Yes	89	44.5
	No	111	55.5
PNB Type (Dichotomized)	Distal Brachial Plexus Block	104	52.0

	Proximal Block	Brachial Plexus	96	48.0
Duration of Motor Block	<8.84hr		126	63.0
	≥8.84 hr		74	37.0
Duration of Sensory Block	<10.05 hr		100	50.0
	≥10.05 hr		100	50.0
Time to Block Resolution	<15.44 hr		109	54.5
	≥15.44 hr		91	45.5

Footnote: NSAIDs; Non-steroidal anti-inflammatory drugs, PNB; Peripheral nerve block, Proximal brachial plexus block (Interscalene and supraclavicular), Distal brachial plexus block(axillaries and wrist)

Descriptive Statistics of Continuous Variables

Normality assessment through skewness and kurtosis values indicated that all variables were approximately normally distributed, with skewness values between -0.304 and 0.709, reflecting a balanced and near-symmetrical distribution of the data (Table 5).

Table 5. Descriptive statistics for continuous variables

Variables	N	Min	Max	Mean±SD	Skewness	Kurtosis
Duration of tourniquet(min)	76	31	96	67.48±18.46	-.288	-.864
Volume of LA(mL)	200	14	40	30.04±6.77	-.304	-.627
Time to Block resolution(h)	200	8	23	15.44±4.62	.079	-1.218
Duration of surgery(h)	200	1	3	1.50±.63	-.018	-1.050
Duration of Motor Block(h)	200	5	16	8.84±2.81	.615	-.494
Duration of Sensory Block(h)	200	6	18	10.05±2.65	.709	-.047

Footnote: LA; Local anesthetic, SD; standard deviation, Max; Maximum, Min; Minimum

Incidence of Rebound Pain Following Peripheral Nerve Block

Among 200 patients 89 developed rebound pain, giving incidence of rebound pain (RP) following peripheral nerve block of 44.5% (95% CI: 38.0–51.5) (Figure 1).

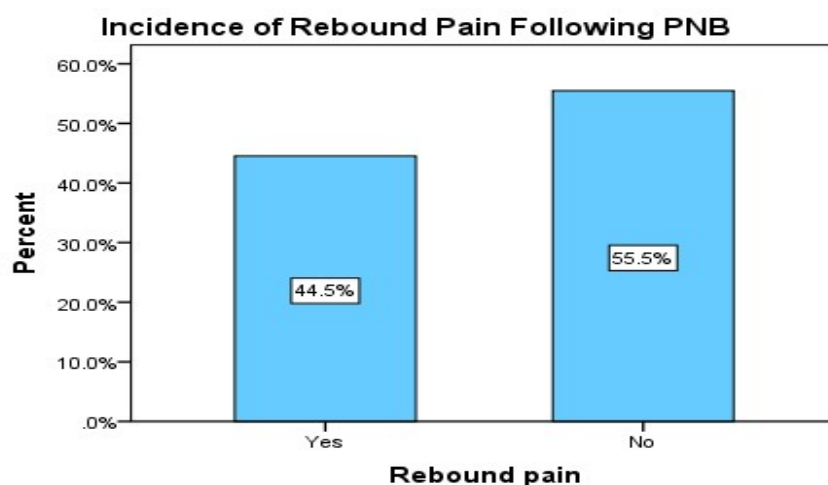


Figure 1. Incidence of rebound pain following peripheral nerve block

Chi-square Analysis of Factors Associated with Rebound Pain Following Peripheral Nerve Block

Pearson's chi-square analysis revealed an association between RP, preoperative pain preoperative pain ($\chi^2 = 16.10$, $p < 0.001$), neutrophil-to-lymphocyte ratio (NLR) ($\chi^2 = 37.30$, $p < 0.001$), dexamethasone premedication ($\chi^2 = 24.90$, $p < 0.001$), intraoperative analgesia ($\chi^2 = 54.80$, $p < 0.001$), and adjuvant use ($\chi^2 = 25.40$, $p < 0.001$). Additionally, perioperative factors such as tourniquet use ($\chi^2 = 6.87$, $p = 0.009$), postoperative opioid use ($\chi^2 = 27.70$, $p < 0.001$), and time to block resolution ($\chi^2 = 19.60$, $p < 0.001$) were also significantly associated with RP. However, no significant associations were found for gender, age, coexisting disease, ASA physical status, preoperative analgesia, urgency of surgery, type of surgery, and various other factors (all $p > 0.05$). Detailed results are provided in Table 6.

Table 6. Chi-square analysis of factors associated with rebound pain following peripheral nerve block

Variable	Category	Rebound pain, Yes n (Expected)	Rebound pain, No n (Expected)	χ^2	P-value
Gender	Male	65 (63.6)	78 (79.4)	0.18	0.660
	Female	24 (25.4)	33 (31.6)		
Age (years)	≥ 60	67 (65.4)	80 (81.6)	0.26	0.600
	< 60	22 (23.6)	31 (29.4)		
Coexisting disease	Yes	26 (25.8)	32 (32.2)	0.81	0.660
	No	63 (62.7)	78 (78.3)		
ASA status	ASA I	14 (11.6)	12 (14.4)	1.06	0.588
	ASA II	45 (46.7)	60 (58.3)		
	ASA $\geq$ III	30 (30.7)	39 (38.3)		
Dexamethasone premedication	Yes	66 (48.5)	43 (60.5)	24.90	<0.001
	No	23 (40.5)	68 (50.5)		
Preoperative pain	Yes	55 (40.9)	37 (51.1)	16.10	<0.001
	No	34 (48.1)	74 (59.9)		
Preoperative analgesia	Yes	41 (35.2)	38 (43.8)	2.80	0.089
	No	48 (53.8)	73 (67.2)		
Tourniquet use	Yes	62 (53.0)	57 (66.0)	6.87	0.009
	No	27 (36.0)	54 (45.0)		

Adjuvant used	Yes	67 (49.4)	44 (61.6)	25.40	<0.001
	No	22 (39.6)	67 (49.4)		
Intraoperative analgesia	No	74 (48.1)	34 (59.9)	54.80	<0.001
	Yes	15 (40.9)	77 (51.1)		
Postoperative opioid	Yes	63 (44.5)	33 (55.5)	27.70	<0.001
	No	26 (44.5)	74 (55.5)		
Time of block resolution	< Mean	64 (48.5)	45 (60.5)	19.60	<0.001
	≥ Mean	25 (40.5)	66 (50.5)		
Tourniquet duration	<67.48 min	16(17.4)	23 (21.6)	1.7	0.42
	≥67.48min	20 (16.5)	17 (20.5)		
Neutrophil-to-lymphocyte ratio	<3	29 (50.3)	84 (62.7)	37.30	<0.001
	≥3	60 (38.7)	27 (48.3)		

ASA: American Society of Anesthesiologists

Bivariable and Multivariable Logistic Regression Analysis

In a bivariable logistic regression analysis, factors associated with rebound pain (RP) included intraoperative analgesia, postoperative opioid use, tourniquet use, dexamethasone premedication, preoperative pain, preoperative analgesia, adjuvant use, time to block resolution and neutrophil-to-lymphocyte ratio (NLR). Variables with a p-value <0.25 and clinically relevant factors were analyzed in a multivariable model. After adjustment for potential confounder's, NLR ≥ 3 (AOR = 8.2; p<0.001) was associated with higher odds of rebound pain, while intraoperative analgesia (AOR = 0.18; p=0.039) and dexamethasone premedication (AOR = 0.39; p=0.04) were associated with lower odds of rebound pain (Table 7).

Table 7. Bivariable and multivariable logistic regression analysis

Variable	Category	COR (95% CI)	P-value	AOR (95% CI)	P-value
Dexamethasone premedication	Yes vs No	0.22 (0.12–0.41)	<0.001	0.39 (0.16–0.96)	0.041
Preoperative pain	Yes vs No	0.31 (0.17–0.55)	<0.001	0.54 (0.22–1.33)	0.180
Preoperative analgesia	Yes vs No	0.61 (0.34–1.08)	0.090	0.65 (0.31–1.40)	0.271
Tourniquet use	Yes vs No	0.46(0.25–0.82)	0.009	0.81 (0.36–1.79)	0.61
Adjuvant use	Yes vs No	0.22 (0.12–0.39)	<0.001	0.87 (0.35–2.20)	0.77
Intraoperative analgesia	Yes vs No	0.09 (0.05–0.18)	<0.001	0.18 (0.04–0.92)	0.039
Postoperative opioid use	Yes vs No	0.21 (0.11–0.38)	<0.001	1.4 (0.34–5.90)	0.638
Neutrophil-to-lymphocyte ratio	≥3 vs <3	6.40 (2.46–11.96)	<0.001	8.2(3.71–18.31)	<0.001
Time to block resolution	Above vs Below mean	0.26 (0.15–0.48)	<0.001	1.29 (0.38–4.41)	0.684

Footnote: CI; Confidence interval, COR; crude odds ratio, AOR; Adjusted Odds ratio, variables with $p < 0.25$ in bivariable analysis and clinically relevant variables were entered into the multivariable model and $p < 0.05$ in multivariable model considered as statically significant.

DISCUSSION

This prospective cohort study examined the incidence and predictors of rebound pain after peripheral nerve block in adult patients undergoing upper extremity orthopedic surgery. It revealed a 44.5% incidence of rebound pain, indicating that nearly half of the patients experienced a significant increase in pain after resolution of the block. This result verifies that rebound pain is a frequent occurrence after surgery in orthopedics, especially within Ethiopian practice(25). The similar incidences have also been reported approximately 40-60% of patients have experienced rebound pain after ambulatory orthopedic and ankle fracture surgeries, as previously reported(21,11). Narrative reviews also show that rebound pain is a major problem for many people who receive single-shot peripheral nerve blocks (19, 30). The results confirm that rebound pain is a frequent phenomenon following surgery, not an isolated event. Variations in reported incidence arise from differences in patient characteristics, surgical techniques, nerve block methods, anesthetic agents, analgesic protocols, and definitions of rebound pain. In addition, differences in healthcare systems, access to acute pain services, and patient education can affect how often rebound pain is reported.

One of the notable findings of this study is that receipt of intraoperative analgesia was associated with lower odds of rebound pain. This observation is consistent with interventional evidence that timely intraoperative analgesia can mitigate severe rebound pain by enhancing transitional analgesia during the resolution of the block (28). Previous reviews also emphasized the importance of administering systemic analgesics before resolution of the block for preventing rebound pain (13, 30). Analgesia administered during surgery may have a biological link to reduced nociceptive transmission as the patient moves from sensory blockade to the return of nerve function. Although the observational nature of the study cannot establish causality, this short-lived analgesia might lessen the abrupt exposure to unrelieved surgical nociception.

The other finding of this study dexamethasone premedication was associated with lower odds of rebound pain. Dexamethasone can prolong the duration of peripheral nerve blocks and reduce postoperative inflammation, contributing to a smoother recovery, even though the observational design of the study limits any causal conclusions (13,30). The strong association observed between NLR $\geq$ and Rebound pain suggests that preoperative inflammatory status may have potential value in identifying patients an increase risk However, this finding should be interpreted cautiously and requires external validation before NLR can be recommended as clinical predictive marker. Higher NLR levels, which serve as a biomarker of systemic inflammation, can amplify inflammatory responses and make postoperative pain more severe (13). Since NLR is a widely recognized biomarker of systemic inflammation, patients with elevated NLR may have greater inflammatory responses after tissue injury, predisposing them to more severe postoperative pain. Furthermore, prior prediction models and a retrospective cohort study identified inflammatory and patient-related characteristics as significant contributors to severe rebound pain. (26,27).

Even though NLR was not directly assessed, these studies suggest that inflammatory status influences the intensity of rebound pain. Thus, with these findings, the current study suggests that NLR could serve as a simple and cost-effective biomarker to identify patients at higher risk of rebound pain prior to surgery. The present study did not demonstrate statistically significant independent associations between rebound pain and tourniquet use, postoperative opioid use, adjuvant use, or preoperative pain after multivariable adjustment. Although prolonged tourniquet inflation has previously been associated with ischemia-reperfusion injury and increased postoperative pain, the absence of an independent association in the current study agrees with previous study, who found that procedural characteristics frequently lose significance after adjustment for analgesic and patient-related factors (21). Similarly, perioperative analgesic management has a greater influence on rebound pain than most surgical variables (27).

Likewise, preoperative pain and postoperative opioid administration were not independently associated with rebound pain. Comparable observations were reported by previous where baseline pain characteristics lost statistical significance after adjustment for multiple clinical variables (26). These results suggest that rebound pain is shaped considerably by postoperative inflammatory responses and analgesic approaches, to a greater degree than by baseline pain intensity or the use of opioids on its own. Overall, the findings support that rebound pain is multifactorial and associated with inflammatory status, perioperative analgesic management, and individual patient characteristics. The observed associations of intraoperative analgesia and dexamethasone premedication with lower odds of rebound pain along with the association of elevated NLR with higher odds, identify clinically relevant areas for further investigation and risk-informed perioperative care.

IMPLICATIONS

The results indicate better perioperative pain management for orthopedic surgery, with an emphasis on rebound pain after single-shot peripheral nerve blocks. Before the block wears off, clinicians ought to use evidence-based multimodal analgesia. Moreover, the link between a higher neutrophil-to-lymphocyte ratio and rebound pain suggests that low-cost laboratory markers could be used for risk assessment, provided they are validated in larger studies. Institutions should establish standardized protocols for rebound pain management within enhanced recovery frameworks and provide educational initiatives to anesthesia professionals to recognize and prevent rebound pain, thus supporting personalized pain management in low-resource environments.

LIMITATIONS

Some limitations of the study include its single center design; observational design and therefore inability to establish causality; possibility residual/ unmeasured confounding; heterogeneity in surgical procedure and analgesic regimens; missing data for some variables; reliance on patient-reported pain scores; and the absence of some potentially relevant psychological variables.

CONCLUSION

Rebound pain was common among adult patients undergoing upper extremity orthopedics' surgery following peripheral nerve block. Neutrophil-to-lymphocyte ratio (NLR) ≥ 3 was independently associated with higher odds of rebound pain, whereas dexamethasone premedication and intraoperative analgesia were associated with lower odds. These results assist in identifying potentially higher- risk patients and informing future research and perioperative pain management strategies. Further multicenter studies and external validation are required before these findings can be incorporated into predictive clinical practice

RECOMMENDATIONS

Based on the study's findings, the following recommendations are made: For clinical practice, hospitals should enhance multimodal transitional analgesia protocols and evaluate the role of dexamethasone in relevant studies. The preoperative neutrophil-to-lymphocyte ratio should be further assessed as a risk marker. For hospitals and policymakers, there is a need to create guidelines for preventing and managing rebound pain after peripheral nerve blocks and to incorporate standardized patient education into perioperative care. In education, training for anesthesia providers should focus on identifying and managing rebound pain with evidence-based analgesic strategies. Subsequent investigations ought to center on multicenter trials involving bigger sample sizes to confirm the results, investigate ideal analgesic regimens, evaluate how well inflammatory biomarkers predict outcomes, and contrast continuous peripheral nerve blocks with single-shot approaches for handling rebound pain.

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Authors contribution statement

BMA participated in the conception and design of the study, data collection, data analysis, interpretation of the results, and preparation of the manuscript. Prof. Adebisola, who supervised, provided guidance throughout the research process, participated in the design of the study and the interpretation of the results, and critically revised and reviewed the manuscript. Both authors approved the final version of the manuscript.

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Availability of data and materials

The data sets used and analyzed during the study are available from the corresponding author on reasonable request.

Abbreviations

AOR; Adjusted odds Ratio, ASA; American Society of Anesthesiologists, BMI; Body mass index, COR; Crude Odds Ratio, DM; Diabetes mellitus, HD; Heart Disease, HTN; Hypertension, LA; Local Anesthetics, NLR; Neutrophil-lymphocyte Ratio, NSAIDs; non-steroidal anti-inflammatory drugs, PCM; paracetamol, PNB; Peripheral Nerve Block, RP; Rebound pain, TORG; The Operating Room Global

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Tables and Figures

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Table 5. Descriptive statistics for continuous variables

Table 6. Chi-square analysis of factors associated with rebound pain following peripheral nerve

Table 7. Bivariable and multivariable logistic regression analysis

Figure 1. Incidence of rebound pain following peripheral nerve block.

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