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Original Research Article

The effect of preoperative neutrophil-to-lymphocyte ratio on pain, swelling, trismus, and healing following mandibular third molar surgery

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Abstract – Background: The ratio of neutrophils to lymphocytes (NLR) has been suggested as an inflammatory biomarker that could potentially predict complications after surgery. **Methods:** A prospective cohort study comprised 150 patients aged between 18 and 35 yr undergoing surgical removal of impacted mandibular third molars. Patients were stratified into high NLR ($\geq$2.8) and low NLR ($<$2.8) groups based on preoperative complete blood count results. Primary outcomes included pain measured by the Visual Analog Scale, swelling through facial measurements, trismus assessed through maximum interincisal distance, and healing indices measured at predetermined intervals up to 14 days postoperatively. **Results:** The high NLR group had significantly higher pain scores at 6 h (6.8 ± 1.4 *vs.* 5.2 ± 1.6; p <0.001), at 24 h (5.9 ± 1.5 *vs.* 4.3 ± 1.7; p <0.001), and at 48 h (4.7 ± 1.3 *vs.* 3.5 ± 1.4; p <0.001) in comparison to the low NLR group. Maximum swelling was more in the high NLR group at 48 h with results of a difference found to be significant between groups: mean difference was 12.3 ± 3.2 mm for the former and 9.1 ± 2.8 mm for the latter (p <0.001). Trismus was more severe in high NLR patients at 48 h with a mean difference of 21.4 ± 56 mm *versus* 26.8 ± 4.9 mm among low-NLR patients (p <0.001). Delayed healing occurred in 28% of high-NLR patients compared to only 12% among low-NLR patients (p = 0..024). **Conclusion:** Increased preoperative NLR is associated with increased postoperative pain, swelling, trismus, and delayed healing after extraction of mandibular third molars; hence it could be an important predictor for risk stratification and improved perioperative management.

Introduction

Surgical extraction of impacted mandibular third molars is one of the most common procedures performed in oral and maxillofacial surgery with millions being extracted annually across the globe [1]. Some complications such as pain, swelling, trismus, and delayed healing that still significantly affect patients' quality of life despite improvements in surgical techniques and perioperative management continue to be reported [2]. The inflammatory response that occurs after tissue injury during surgery is a determinant factor for the intensity and duration of these complications [3].

The neutrophil-lymphocyte ratio (NLR) is an easy, cheap, and readily available inflammatory marker derived from routine complete blood count tests [4]. This ratio represents the balance between innate and adaptive immune responses; neutrophils indicate the primary inflammatory response while lymphocytes indicate regulatory control by the immune system [5]. High levels of NLR have been associated with increased systemic inflammation and poor prognosis in several cancers including oral cancer [6].

The NLR has been widely studied as a predictor in cardiovascular, cancer surgeries, and general surgical procedures. In all these studies high preoperative NLR was associated with poor postoperative outcomes [7]. The NLR holds great promise for predicting postoperative complications, hospital

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length of stay, and general morbidity [8]. Its use in oral and maxillofacial surgery is still under-investigated, although recent studies have emphasized its potential role in the prognosis of odontogenic infections [9] and oral cancer [10].

The inflammatory cascade triggered by surgical trauma is primarily responsible for the postoperative complications after third molar surgery [11]. The degree of this inflammatory reaction varies significantly between individuals and is influenced by various factors such as genetic susceptibility, immune function, and baseline inflammatory markers [12]. Recognizing these individual variations through readily available biomarkers may enable surgeons to excute personalized perioperative strategies, potentially minimizing morbidity and improving patient outcomes.

Numerous studies have tried to determine predictive factors related to complications after third molar surgery. Most have concentrated on the characteristics of the tooth and the surgical technique [13]. Possible factors include: age, gender, general health, use of oral contraceptive, preexisting pericoronitis, poor oral hygiene, smoking, type of impaction, duration of surgery, experienced surgeon, prophylaxis with antibiotics, topical antiseptics, intra-socket dressing, and the method of anesthesia [14]. Nevertheless, the role of systemic inflammatory markers, particularly NLR, in predicting postsurgical outcomes has received limited consideration in the oral surgery literature.

Considering the scarce data concerning the link between NLR and postoperative outcomes in oral surgery, this research was conducted to assess the predictive value of preoperative NLR in individuals undergoing surgical removal of impacted mandibular third molars. The aim is to determine if this easily obtainable biomarker can reliably predict postsurgical pain, swelling, trismus, and wound healing, potentially transforming perioperative management strategies in oral and maxillofacial surgery.

Methods

This observational cohort study was prospectively carried out at the oral and maxillofacial surgery department of Erbil teaching dental hospital, Iraq during a 30-month time frame, spanning from February 2023 to July 2025. The Institutional Ethics Committee approved the study protocol (KHCMS approval No. 1346, dated 18-1-2023), and the procedures were conducted following the Declaration of Helsinki and Good Clinical Practice standards [15].

A total of 150 patients set for surgical extraction of impacted lower wisdom teeth were recruited *via* convenience sampling from the outpatient clinic. Sample size determination was executed utilizing G*Power software (version 3.1.9.7) according to a two-tailed t-test with an effect size of 0.5, α-error of 0.05, and power of 80%, leading to a minimum necessary sample of 128 patients. To accommodate possible dropouts, the sample size was raised to 150 patients (Fig. 1).

Participants age were 18 to 35 yr, with both clinical and radiographic evidence justifying the surgical extraction of an impacted mandibular third molar. Eligible participants were categorized as American Society of Anesthesiologists (ASA) physical status I or II, capable of comprehending the study procedures, and willing to give informed consent. Moreover, participants were required to be present for all follow-up sessions.

The exclusion criteria eliminated individuals showing signs of acute pericoronitis or abscess at the surgical location, a background of systemic inflammatory diseases like rheumatoid arthritis, inflammatory bowel disease, or systemic lupus erythematosus, along with those having immunodeficiency disorders or receiving immunosuppressive treatment. Patients who had taken corticosteroids, non-steroidal anti-inflammatory drugs, or antibiotics in the seven days leading up to surgery were excluded, along with pregnant or breastfeeding women. People with blood disorders or clotting issues, a past of negative responses to local anesthetics or medications, or those who cannot keep proper oral hygiene or follow postoperative guidelines were also excluded.

All eligible patients underwent comprehensive preoperative evaluation including medical history, clinical examination, and radiographic assessment using orthopantomogram (OPG) and cone-beam computed tomography (CBCT) when indicated. Surgical complexity was assessed using the Pederson Difficulty Index, which considers spatial relationship, depth of impaction, and angulation of the impacted tooth [16].

Blood samples for complete blood count analysis were obtained 24–48 h before surgery. The NLR was determined by dividing the absolute count of neutrophils by the absolute count of lymphocytes [17]. Using the median NLR value from the study population (2.8), patients were categorized into two groups: low NLR group (NLR $<$ 2.8) and high NLR group (NLR $\geq$ 2.8).

All surgical procedures were performed by the same experienced oral and maxillofacial surgeon to minimize inter-operator variability. A standardized surgical protocol was followed for all cases. Surgery was done under local anesthesia using 2% lidocaine with 1:100,000 adrenaline, up to a maximum volume of 7 ml. A standard envelope flap or a triangular flap design was used based on clinical requirements. A full-thickness mucoperiosteal flap was elevated using periosteal elevators and bone removal was performed with a surgical handpiece under copious saline irrigation. Tooth sectioning, when required, was done with a high-speed handpiece and sectioning burs. The extraction socket was debrided and flushed with normal saline to remove any debris and the wound closure was done using 3-0 silk suture [18]. Surgical time was defined as the interval from mucosal incision to the completion of the last suture. All patients received standardized postoperative instructions and medication protocols.

Antibiotic coverage with amoxicillin 500 mg three times a day for five days was provided. Azithromycin 500 mg once daily for three days was given in case of penicillin allergy. Analgesia was provided with ibuprofen 400 mg thrice daily for three days, and paracetamol 600 mg every 6 h was advised as a rescue analgesic. Patients were also instructed to maintain optimal oral hygiene by using chlorhexidine mouthwash 0.2% twice daily for seven days.

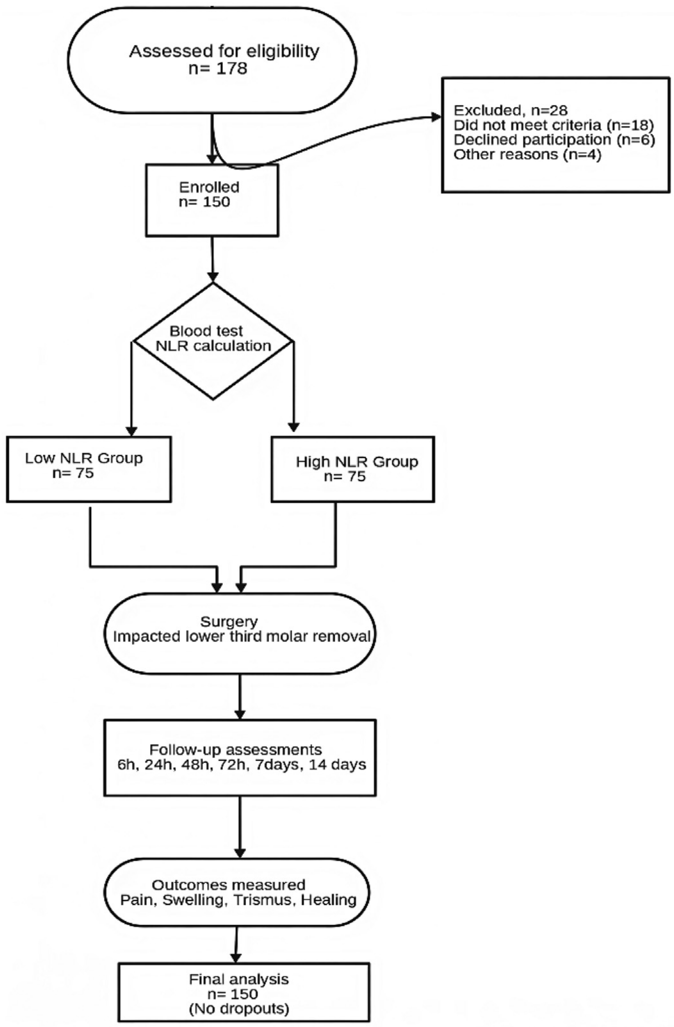

Fig. 1. Flowchart of the Study.

Postoperative care involved instructing the patient to apply a cold compress over the site for 24 h to minimize swelling. A soft diet was recommended for 3–5 days with maintenance of oral hygiene and avoidance of the surgical area. Physical activities were restricted for 24–48 h. Follow-up appointments were scheduled as per the treatment plan, to monitor healing and manage any complications.

Pain intensity was assessed through a 10-centimeter Visual Analog Scale, where zero indicated "no pain" and ten meant "worst possible pain" [19]. Pain scores were noted at specific time points from preoperative baseline up to 7 days after the operation.

Facial swelling was measured using the three-point method [19]. This included measurements from the tragus to the pogonion, from the gonion to the lateral canthus, and from the gonion to the pogonion. The sum of the three measurements was considered.

The maximum mouth opening was measured with a digital caliper at the incisal edges of maxillary and mandibular central incisors [19].

Socket healing was assessed using the Landry Wound Healing Index at 7 and 14 days postoperatively [20]. This index evaluates soft tissue color, bleeding response, granulation tissue formation, incision margins, and suppuration on a scale of 1–5 for each parameter (total score 5–25; higher scores indicate better healing).

Statistical analysis was performed using SPSS version 28.0 (IBM Corp., Armonk, NY, USA). The Shapiro-Wilk test was applied to assess the normality of data distribution. Independent *t*-test was used for normally distributed continuous variables, and Mann-Whitney U test was conducted for non-parametric data. Categorical variables were analyzed using chi-square tests or Fisher's exact tests when appropriate. Changes in pain scores, swelling, and trismus over time between groups were assessed by repeated measures ANOVA. Pearson or Spearman correlation coefficients were computed to determine the relationship between NLR and outcome variables. A multiple linear regression analysis was conducted to find independent predictors of postoperative outcomes while controlling for confounding variables such as age, gender, BMI, smoking status, surgical difficulty, and time taken for the operation. Statistical significance was set at $p < 0.05$ and 95% confidence intervals were calculated for all estimates.

Results

A total of 150 patients completed the study with no dropouts. The study population consisted of 82 females (54.7%) and 68 males (45.3%) with a mean age of 24.6 ± 4.2 yr. Patients were assigned to low- and high NLR groups according to the median NLR value of 2.8, with an equal distribution between them ($n = 75$ each), as shown in Table I. The hematological parameters of the two groups is presented in Table II.

Pain scores showed significant differences between groups at multiple time points. The high NLR group consistently experienced higher pain intensity compared to the low NLR group throughout the early postoperative period (Tab. III). Repeated measures ANOVA revealed a significant group × time interaction ($F = 12.4$, $p < 0.001$), indicating that the pain trajectory differed between NLR groups. Peak pain occurred at 6 h in both groups, but the high NLR group showed a slower decline in pain intensity.

The swelling index, maximum mouth opening, and trismus severity were significantly higher in the High NLR group than the low NLR group at the 48 h and 7 days time points (Tab. IV).

Wound healing assessment using the Landry index showed significant differences between groups. At 7 days, the mean healing score was 18.4 ± 2.6 in the low NLR group compared to 16.2 ± 3.1 in the high NLR group ($p < 0.001$). By 14 days, healing scores improved to 22.1 ± 1.8 and 20.3 ± 2.4, respectively ($p < 0.001$). Delayed healing (defined as Landry score <15 at day 7) occurred in 9 patients (12.0%) in the low NLR group *versus* 21 patients (28.0%) in the high NLR group ($\chi^2 = 5.4$, $p = 0.024$) Table V.

Table I. Baseline characteristics of study population.

Characteristic	Low NLR Group)	High NLR Group	p-value
Age (years)	24.2 ± 4.1	25.0 ± 4.3	0.237
Gender			0.584
Male	32 (42.7%)	36 (48.0%)	
Female	43 (57.3%)	39 (52.0%)	
BMI (kg/m^2)	23.4 ± 3.6	24.1 ± 3.8	0.284
Smoking Status			0.445
Non-smoker	58 (77.3%)	54 (72.0%)	
Smoker	17 (22.7%)	21 (28.0%)	
ASA Classification			0.572
ASA I	61 (81.3%)	58 (77.3%)	
ASA II	14 (18.7%)	17 (22.7%)	
Pederson Difficulty Index	6.8 ± 2.1	7.2 ± 2.3	0.293
Surgical Time (minutes)	28.4 ± 8.6	31.2 ± 9.4	0.062
Preop NLR	2.1 ± 0.4	4.2 ± 1.3	$<$0.001

Postoperative complications were more frequent in the high NLR group (Tab. VI). Dry socket: 2 (2.7%) *vs.* 8 (10.7%), $p = 0.048$; Secondary infection: 1 (1.3%) *vs.* 5 (6.7%), $p = 0.098$; and Prolonged bleeding: 3 (4.0%) *vs.* 7 (9.3%), $p = 0.193$. Patient satisfaction scores (1–5 scale) were significantly lower in the high NLR group (3.2 ± 0.8 *vs.* 3.8 ± 0.7, $p < 0.001$). Time to return to normal activities was prolonged in high NLR patients (4.8 ± 1.6 *vs.* 3.9 ± 1.3 days, $p < 0.001$).

Preoperative NLR had strong positive correlations with postoperative pain ($r = 0.562$, $p < 0.001$) and swelling ($r = 0.484$, $p < 0.001$), and moderate correlations with trismus ($r = 0.423$) and analgesic use ($r = 0.391$). It was negatively correlated with healing score ($r = -0.508$, $p < 0.001$) and patient satisfaction ($r = -0.452$, $p < 0.001$), while being positively correlated with delayed return to normal activities ($r = 0.367$, $p < 0.001$), as shown in Table VII.

The regression analysis validated that NLR is an independent predictor of postoperative outcomes. High NLR levels increased pain significantly ($\beta = 0.521$, $p < 0.001$) and swelling ($\beta = 0.442$, $p < 0.001$) and reduced healing scores ($\beta = -0.467$, $p < 0.001$). Other factors included surgical complexity, longer surgical time, and older age that contributed to worse outcomes explaining 32–41% of the variance in the models, as shown in Table VIII.

Discussion

The present study investigates the relationship between preoperative neutrophil-to-lymphocyte ratio and postoperative outcomes following mandibular third molar surgery. The findings demonstrate that elevated preoperative NLR is significantly associated with increased postoperative pain, swelling, trismus, and delayed healing, suggesting its potential utility as a predictive biomarker for risk stratification in oral surgery patients.

The most important result of this study was the consistent association between high NLR and greater postoperative pain intensity. Patients with high NLR had significantly higher pain scores at all times measured, with the biggest differences seen in the first 48 h after surgery. These findings agree with evidence from various surgical specialties that show how NLR can predict postoperative pain [12–23].

Recent studies have established the relationship between NLR and postoperative pain for different oral surgical procedures. Turgut *et al.* reported similar findings in orthognathic surgery patients, where high preoperative inflammatory markers were associated with increased postoperative pain scores and higher consumption of analgesics [24]. Yilmaz *et al.* also found a significant correlation between pain and NLR during the first 6 h after lower third molar extraction [25].

The correlation coefficient between NLR and peak pain score in our study was $r = 0.562$, which is significantly higher than those reported in earlier surgical studies. The fact that this has a stronger correlation in oral surgery may suggest that the inflammatory response is more localized and there is an even more direct connection between local tissue trauma and pain perception.

The high correlation between increased NLR and greater swelling after surgery in our study ($r = 0.484$) provides strong evidence of the relation between this biomarker and inflammatory responses. The peak swelling observed at 48 h postoperatively was significantly greater in the high NLR group (12.3 ± 3.2 mm *vs.* 9.1 ± 2.8 mm), with differences persisting at 7 days. Similarly, Varol *et al.* (2025) found that after bimaxillary orthognathic surgery (LeFort I and SSRO), postoperative facial oedema was significantly greater in the NLR ≥2.00 group in the first 10 days [26].

A study by Graziani *et al.* (2017) demonstrated that third molar extraction triggers a significant systemic inflammatory response, with elevated white blood cell counts and peaks in

Table II. Preoperative hematological parameters.

Parameter	Low NLR group	High NLR group	p-value
Total WBC ($\times 10^3/\mu L$)	6.8 ± 1.4	8.2 ± 1.8	<0.001
Neutrophils ($\times 10^3/\mu L$)	3.8 ± 0.9	5.9 ± 1.4	<0.001
Lymphocytes ($\times 10^3/\mu L$)	1.9 ± 0.4	1.4 ± 0.3	<0.001
Neutrophil %	55.2 ± 6.8	71.8 ± 7.2	<0.001
Lymphocyte %	28.4 ± 5.6	17.2 ± 4.3	<0.001
Hemoglobin (g/dL)	13.2 ± 1.6	13.0 ± 1.4	0.456
Platelet Count ($\times 10^3/\mu L$)	286 ± 54	298 ± 62	0.234

Table III. Pain scores (VAS 0-10) at different time points.

Time point	Low NLR group	High NLR group	Mean difference	95% CI	p-value
Baseline	0.3 ± 0.8	0.4 ± 0.9	−0.1	−0.4 to 0.2	0.524
6 hours	5.2 ± 1.6	6.8 ± 1.4	−1.6	−2.1 to −1.1	<0.001
24 hours	4.3 ± 1.7	5.9 ± 1.5	−1.6	−2.1 to −1.0	<0.001
48 hours	3.5 ± 1.4	4.7 ± 1.3	−1.2	−1.7 to −0.7	<0.001
72 hours	2.4 ± 1.2	3.3 ± 1.4	−0.9	−1.4 to −0.4	0.001
7 days	1.1 ± 0.9	1.6 ± 1.1	−0.5	−0.8 to −0.1	0.008

Table IV. Swelling, mouth opening and trismus measurements.

Parameter	Time	Low NLR group	High NLR group	p-value
Swelling Index (mm)	48 hours	9.1 ± 2.8	12.3 ± 3.2	<0.001
	7 days	3.2 ± 1.9	5.1 ± 2.4	<0.001
Maximum Mouth Opening (mm)	Baseline	42.8 ± 5.2	41.9 ± 4.8	0.292
	48 hours	26.8 ± 4.9	21.4 ± 5.6	<0.001
	7 days	37.2 ± 4.6	33.8 ± 5.4	<0.001
Trismus Severity (mm reduction)	48 hours	16.0 ± 4.8	20.5 ± 6.2	<0.001
	7 days	5.6 ± 3.2	8.1 ± 4.1	<0.001

Table V. Wound healing assessment (Landry index).

Parameter	Low NLR group	High NLR group	p-value / χ^2
Mean Healing Score (Day 7)	18.4 ± 2.6	16.2 ± 3.1	$p < 0.001$
Mean Healing Score (Day 14)	22.1 ± 1.8	20.3 ± 2.4	$p < 0.001$
Delayed Healing (Score <15 at Day 7)	9 patients (12.0%)	21 patients (28.0%)	$\chi^2 = 5.4, p = 0.024$

Table VI. Postoperative complications.

Complication	Low NLR group	High NLR group	p-value
Dry socket	2 (2.7%)	8 (10.7%)	$p = 0.048$
Secondary infection	1 (1.3%)	5 (6.7%)	$p = 0.098$
Prolonged bleeding	3 (4.0%)	7 (9.3%)	$p = 0.193$

Table VII. Correlation between preoperative NLR and postoperative outcomes.

Outcome variable	Correlation coefficient (r)	*p*-value	95% CI
Peak pain score (6 hours)	0.562	<0.001	0.442 to 0.661
Maximum swelling (48 hours)	0.484	<0.001	0.351 to 0.599
Maximum trismus (48 hours)	0.423	<0.001	0.281 to 0.548
Total analgesic consumption	0.391	<0.001	0.244 to 0.520
Healing score at day 7	−0.508	<0.001	−0.620 to −0.378
Time to return to normal activities	0.367	<0.001	0.217 to 0.500
Patient satisfaction score	−0.452	<0.001	−0.573 to −0.316

Table VIII. Multiple linear regression analysis for postoperative outcomes.

	Predictor variable	β coefficient	SE	*p*-value
Peak Pain Score Model (R^2 = 0.412, $p < 0.001$)	NLR	0.521	0.089	<0.001
	Surgical complexity	0.283	0.091	0.002
	Age	0.187	0.082	0.024
	Gender (male)	0.146	0.085	0.087
Maximum Swelling Model (R^2 = 0.354, $p < 0.001$)	NLR	0.442	0.094	<0.001
	Surgical time	0.312	0.093	0.001
	Gender (male)	0.218	0.087	0.012
	Smoking status	0.163	0.091	0.075
Healing Score Model (R^2 = 0.328, $p < 0.001$)	NLR	−0.467	0.096	<0.001
	Age	−0.245	0.089	0.007
	Surgical complexity	−0.198	0.092	0.032
	BMI	−0.154	0.088	0.083

C-reactive protein and fibrinogen levels during the first postoperative week [27]. Kumar *et al.* (2023) further supported the clinical utility of NLR as an inflammatory marker, with an optimal cut-off value for predicting severe inflammatory responses in head and neck surgeries [28].

Our results demonstrate a significant correlation between preoperative NLR and postoperative trismus severity. The correlation coefficient of $r = 0.423$ between NLR and maximum trismus is a novel finding in the oral surgery literature. The most probable reason for the NLR-trismus association is that the inflammatory mediators cause muscle spasm and tissue edema in the masticatory space.

High NLR and delayed wound healing may be the most clinically significant association in this study. Patients in the high NLR group had consistently lower Landry wound healing index scores, with a markedly higher incidence of delayed healing at 7 days postoperatively (28% *vs.* 12%). Also, there was a higher occurrence of dry socket in this group (10.7% *vs.* 2.7%), which further underscores the clinical importance of elevated NLR due to the considerable discomfort associated with this complication.

Recent evidence suggests that neutrophils have both beneficial and harmful effects on wound healing. Neutrophils are important for the early stages of wound healing by helping to clear debris and their antibacterial activity. However, when neutrophils are overactive or remain activated for too long, they can actually hinder the healing process by causing tissue damage and interfering with new blood vessel formation [29]. A recent study by Zhao *et al.* (2025) that wound healing in patients with Wagner grade 3 and 4 diabetic foot ulcers after tibial cortex transverse transport surgery was faster in patients with low NLR as compared to those with high NLR [30]. Our study extends these findings to oral surgery, suggesting that elevated baseline NLR may indicate a predisposition to excessive inflammatory responses that impair healing.

The clinical implications of our findings are substantial, particularly considering the cost-effectiveness and accessibility of NLR assessment. Unlike specialized inflammatory markers such as interleukin-6 or tumor necrosis factor-α, which require expensive immunoassays, NLR can be calculated from routine complete blood count tests that is relatively cheap and are widely available [31].

For patients with elevated NLR, clinicians could implement enhanced protocols including preoperative anti-inflammatory medications, modified surgical techniques, intensive postoperative monitoring, and prophylactic interventions for complications. Recent advances in perioperative care have shown that targeted interventions based on inflammatory biomarkers can significantly improve surgical outcomes. Using inflammatory biomarkers to direct perioperative care approaches can significantly improve surgical results. Through the observation of these biomarkers, clinicians can recognize patients with increased risk for complications and customize interventions appropriately, which may result in better recovery and fewer negative events [32].

Several limitations of this study should be acknowledged. First, the single-center design may limit generalizability compared to multi-center studies. Second, while we controlled for major confounding variables, other factors such as genetic polymorphisms affecting inflammatory responses, nutritional status, and psychological factors may influence outcomes. Third, our study focused on short-term outcomes up to 14 days postoperatively.

The cut-off value of 2.8 used in our study was based on the median NLR of our population, which may not be optimal for other populations. Future studies should investigate population-specific cut-off values and potentially develop age- and gender-adjusted NLR thresholds for clinical use.

Conclusions

This prospective cohort study provides compelling evidence that preoperative neutrophil-to-lymphocyte ratio serves as a valuable predictor of postoperative outcomes following mandibular third molar surgery. Patients with high NLR ($\geq$2.8) had significantly greater pain, swelling, trismus, and delayed healing than those with lower ratios.

Incorporating inflammatory biomarkers like NLR into clinical practice represents a significant important advancement toward tailored medical prescription in oral and maxillofacial surgery. It allows for evidence-based risk assessment and individualized treatment planning, which can improve patient care and surgical outcomes.

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Conflicts of interest

The authors declare no conflicts of interest in relation to this article.

Data availability statement

The data are available on request by contacting the corresponding author, Shehab A. Hamad, shehab.ahmed@khcms.edu.krd.

Author contribution statement

S. A. Hamad: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Writing – Original draft. K. K. Xailani: Investigation, Data curation, Validation. A. D. Aldawoody: Formal analysis, Visualization, Writing – Review & Editing. N. P. Philip: Investigation, Resources, Validation. M. S. Ahmed: Supervision, Project administration, Writing – Review & Editing.

Ethics approval

The research protocol was reviewed and approved by Kurdistan Higher Council of Medical Specialties (Approval No. 1346; January 18, 2023).

Informed consent

Written informed consent was obtained from all patients.

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