

Is there a correlation between preoperative neutrophil-to-lymphocyte, platelet-to-lymphocyte, and lymphocyte-to-monocyte ratios and postoperative pain in video-assisted thoracoscopic surgery?

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Abstract

Many thoracic surgery procedures are now performed with video-assisted thoracoscopic surgery (VATS). Postoperative pain is a common condition in patients undergoing VATS. In this study, we aimed to investigate whether neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and lymphocyte-to-monocyte ratio (LMR) are effective in evaluating postoperative pain in patients undergoing VATS.

This prospective observational study was performed between March 2021 and September 2021 at a tertiary thoracic surgery center. The study included patients who had undergone elective VATS. Preoperative and postoperative NLR, PLR, LMR, hemogram values and postoperative visual analog scale (VAS) were recorded.

A total of 105 patients were analyzed. A positive correlation was observed between postoperative monocyte, neutrophils and VAS resting and VAS cough levels in the early postoperative period. No significant correlation was found between preoperative and postoperative NLR, PLR, and LMR values and VAS rest and VAS cough values. When compared to the preoperative period, a negative correlation was found between the change in the postoperative LMR value and the VAS rest and VAS cough values in the early postoperative period.

When compared to the preoperative period, the change in postoperative neutrophil, postoperative monocytes, and postoperative LMR values in patients undergoing VATS in thoracic surgery can be used as a guide in the objective evaluation of postoperative acute pain. It is the belief of the researchers that comprehensive new studies on this subject will contribute significantly to the determination of objective criteria in postoperative pain evaluation.

Abbreviations: ASA = American Society of Anesthesiologists, IQR = interquartile range, IV = intravenous, LMR = lymphocyte/monocytes rate, MPV = mean platelet volume, NLR = neutrophil/lymphocyte rate, PLR = platelet/lymphocyte rate, PNx = pneumothorax, RDW = red cell distribution width, VAS = visual analogue scale, VATS = video-assisted thoracoscopic surgery.

Keywords: inflammation, lymphocyte-to-monocyte ratio, neutrophil-to-lymphocyte ratio, platelet-to-lymphocyte ratio, postoperative pain, video-assisted thoracoscopic surgery

Design: Prospective observational study

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration (as revised in 2013) and its later amendments or comparable ethical standards.

The study was performed in agreement with the approval of the Ethics Committee (Date: 09.03.2021, number: 2012-KAEK-15/2253)

The authors have no funding and conflicts of interest to disclose.

The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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1. Introduction

Many thoracic surgery procedures are now performed with video-assisted thoracoscopic surgery (VATS).^[1] Postoperative pain is a common condition in patients undergoing VATS, and it has a serious impact on postoperative pulmonary complications. Therefore, postoperative pain control is crucial among patients undergoing VATS. Predicting postoperative pain and evaluating it objectively will facilitate the application of appropriate analgesic therapy. For this purpose, parameters that can be used in postoperative pain assessment are needed. Although different mechanisms of pain can be examined, it is known that inflammation is a very important aspect in the mechanism of pain.^[2] Therefore, a parameter that can assess inflammation can also be used to predict postoperative pain. Neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and lymphocyte-to-monocyte ratio (LMR) are considered among the parameters that can determine prognosis as an indicator of systemic inflammation in patients.^[3–8] It is stated that NLR, PLR and monocyte-to-lymphocyte ratio can show the severity of some diseases and can be used as a diagnostic tool in diseases where inflammation is important such as irritable bowel syndrome and diabetes mellitus.^[9–12] There are studies in the literature showing that NLR, as an inflammatory marker, is associated with disease activity in diseases such as ulcerative colitis and Hashimoto's thyroiditis.^[13,14] It is also stated that PLR can be used in the differentiation of benign and malignant thyroid nodules, and that PLR is associated with hepatitis B-associated liver fibrosis.^[15,16] In addition, there are studies indicating that NLR, PLR and monocyte-to-lymphocyte ratio can be used as an early diagnosis and predictor in many diseases in which inflammation is important.^[17–20] It is known that inflammation plays a very important role and leukocyte ratios change, neutrophil and thrombocyte counts increase, and relative lymphopenia develops after surgical trauma.^[21–24] In addition, due to the significant effect of inflammation on pain, a correlation can be detected between NLR, LMR, or PLR—all of which can be easily calculated with complete blood count parameters—and postoperative pain. In this way, a parameter that can objectively evaluate postoperative pain can be obtained.

In this study, we aimed to investigate whether NLR, PLR, and LMR are effective in evaluating postoperative pain in patients undergoing VATS.

2. Materials and methods

Following the approval of the Ethics Committee (Date: 09.03.2021, number: 2012-KAEK-15/2253), this prospective observational study was performed between March 2021 and September 2021 at a tertiary thoracic surgery center. The study included patients between 18 and 80 years of age who had undergone elective VATS, whose physical condition was I-II-II according to the American Society of Anesthesiologists (ASA), and whose body mass index was between 18.5 and 35 kg/m².

Patients with systemic inflammatory diseases or a history of anti-inflammatory drugs or steroids usage, patients who received intraoperative blood product transfusion, patients with chronic pain prior to the operation, and patients who had previously undergone thoracic surgery were excluded from the study.

The following patient information was recorded: diagnoses; gender; age; body mass index; ASA physical status; preoperative hemogram values; hemogram values at the postoperative first

hour; preoperative and postoperative NLR, PLR, LMR values; surgery performed and any complications developed during the intraoperative or postoperative 24 hours; postoperative rest and cough visual analog scale (VAS); and patient satisfaction with pain management.

NLR was calculated by dividing the absolute neutrophil count by the absolute lymphocyte count. PLR was calculated by dividing the absolute platelet count by the absolute lymphocyte count. LMR was calculated by dividing the absolute lymphocyte count by the absolute monocyte count. VAS evaluation was from 0 (no pain) to 10 (maximum pain). The VAS during rest (VAS Rest) and coughing (VAS Cough) values were measured at the postoperative first hour, second hour, fourth hour, eighth hour, sixteenth hour, and twenty-fourth hour.

2.1. General anesthesia

Written informed consent was obtained from the patients 24 hours prior to the treatment operation. Patients were monitored in the operating room in accordance with the ASA standards, and intravenous (IV) 0.03 mg/kg midazolam was administered to the patients for premedication. After preoxygenation, anesthesia was induced IV with 1.5 to 2.5 mg/kg propofol, 1.5 µg/kg fentanyl, and 0.1 mg/kg vecuronium. Patients were intubated with a double-lumen endobronchial tube. Anesthesia was maintained by administering 2% to 3% sevoflurane in an oxygen and air mixture.

2.2. The block procedure

The block procedure was performed prior to the skin incision and following the induction of anesthesia. The thoracic paravertebral block was performed by injecting 20 ml of 0.25% bupivacaine into the paravertebral area under US guidance while the patients were in the lateral decubitus position.

2.3. Analgesia protocol

Prior to the end of the surgical procedure, dexketoprofen (50 mg) and tramadol (100 mg) were given IV. Postoperatively, patients were given a 24-hour IV morphine infusion with a patient-controlled analgesia pump. Dose delivery of the patient-controlled analgesia pump was limited to administering a bolus dose of 1 mg of morphine and delivering a maximum total dose of 12 mg of morphine over 4 hours at 15-minute lock-in intervals. A paracetamol (1 g) dosage every 8 hours (first dose 8 hours after the end of surgery) and a dexketoprofen (50 mg) dosage twice daily (first dose 12 hours after the end of surgery) were administered IV for multimodal analgesia. As a rescue analgesic agent, 0.5 mg/kg tramadol was given to patients IV when a score of VAS at rest was greater than or equal to 4. Side effects—such as allergic reactions, hypotension, nausea-vomiting, and itching—were recorded.

2.4. Sample size

The sample size was calculated using G*Power© software, version 3.1.9.2 (Institute of Experimental Psychology, Heinrich Heine University, Dusseldorf, Germany). The sample size was calculated for the paired sample *t*-test, and this was used to test the main hypothesis of the present study. Depending on previous research results with a two-sided (two tails) type I error of 0.05

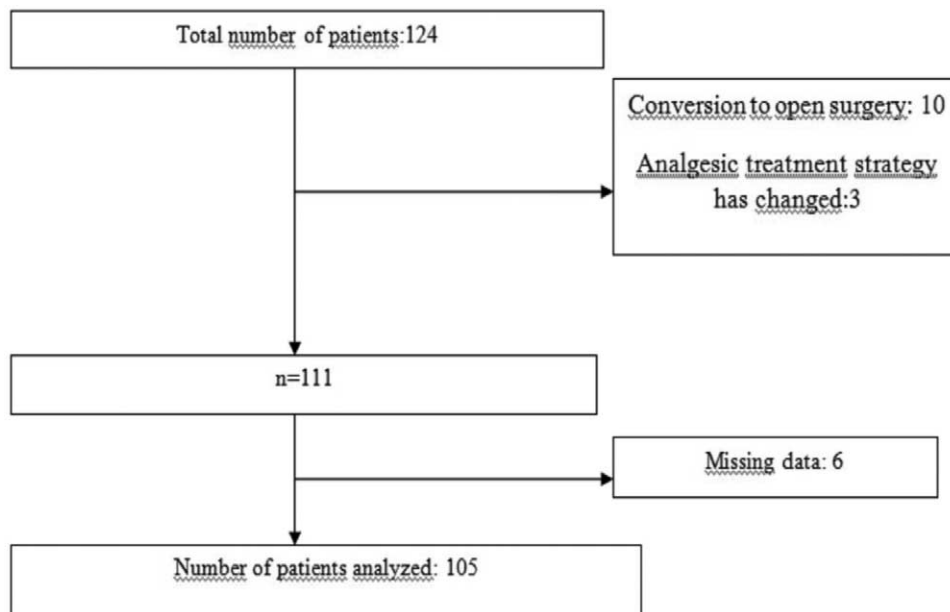


Figure 1. Flow chart of the patients.

and power of 80% ($1 - \beta = 0.8$) and an effect size (d) factor of 0.5 should involve 58 or more subjects.^[8]

2.5. Statistical analyses

Data analyses were performed using SPSS for Windows, version 22.0 (SPSS Inc., Chicago, IL). The Kolmogorov Smirnov test was used to determine whether the distribution of continuous variables were normal or not. The Levene test was used for the evaluation of homogeneity of variances. Unless otherwise specified, continuous data were described as mean \pm standard deviation for normal distributions and median (interquartile range) for skewed distributions. Categorical data were described as the number of cases (%). Statistical analysis differences in abnormally distributed variables between two dependent groups were compared using the Wilcoxon test. Degrees of relation between abnormally distributed variables were evaluated with Spearman correlation analysis. A P -value of $<.05$ was accepted as a significant level on all statistical analysis.

The power of the study was determined to be 84% as a result of the post hoc power analysis performed with a 5% alpha margin of error (one-way), according to the correlation analysis data in the G*Power© software, version 3.1.9.2 (Institute of Experimental Psychology, Heinrich Heine University, Dusseldorf, Germany).

3. Results

Between March 2021 and September 2021, 124 patients who met the inclusion criteria were identified. Ten patients were excluded from the study, as their surgeries began with VATS and transitioned into thoracotomy. Three additional patients were also excluded, as their analgesic treatment strategies were changed. Six patients were missing data. A total of 105 patients were analyzed (Fig. 1).

The demographic data, surgical characteristics, and satisfaction with the analgesia protocol of the patients are given in Table 1.

The postoperative complications of the patients are given in Table 2.

Compared to the preoperative period, the postoperative lymphocyte, RDW, platelet, MPV, and LMR values decreased statistically; monocytes, neutrophils, NLR, and PLR increased statistically (Table 3).

Patients' postoperative VAS rest and VAS cough data of the patients have been provided in Tables 3 and 4.

According to Spearman correlation analysis, no significant correlation was found between preoperative lymphocyte, monocytes, neutrophil, RDW, platelet, MPV, NLR, PLR, and LMR values and VAS rest and VAS cough values ($P > .05$).

A low degree of positive correlation was found between postoperative monocyte values and VAS rest levels during the postoperative second hour and VAS cough levels during the postoperative first and second hour. A low degree of positive correlation was also found between the postoperative neutrophils value and the VAS rest values for the first, second, fourth, eighth, and sixteenth hour as well as the VAS cough values for the first, second, fourth, eighth, and sixteenth hour (Table 5).

According to Spearman correlation analysis, there is no significant correlation between postoperative NLR, PLR, and LMR values and VAS rest and VAS cough values ($P > .05$).

Compared to the preoperative period, the change found in postoperative NLR and PLR values and the VAS relationship was not statistically significant. However, when compared to the preoperative period, the change of the postoperative LMR value and its relationship with VAS for the first, second, fourth, eighth, and sixteenth hour of rest and cough was statistically significant (Table 6).

4. Discussion

In our study, a positive correlation was observed between postoperative neutrophils and VAS rest and VAS cough levels in the early postoperative period. No significant correlation was found between preoperative and postoperative NLR, PLR, and

Table 1
The demographic data, surgical characteristics, and satisfaction with the analgesia protocol of the patients.

Patients (n = 105)	n (%)	
Gender	Female	35 (33.3)
	Male	70 (66.7)
Age (y), mean ± SD	50.85 ± 17.30	
BMI (kg/m ²), mean ± SD	26.69 ± 4.24	
Diagnosis	Mass/nodule	50 (47.6)
	PNX	23 (21.9)
	Bronchiectasis	2 (1.9)
	PleuralEfusion	30 (28.6)
ASA	ASA 1	14 (13.3)
	ASA 2	42 (40.0)
	ASA 3	49 (46.7)
Operation	Wedge/biopsy	75 (71.4)
	Segmentectomy	12 (11.4)
	Lobectomy	18 (17.1)
Patient satisfaction	I'm not satisfied	5 (4.8)
	Moderate	20 (19.0)
	I am satisfied	80 (76.2)

Continuous variables are expressed as either the mean ± SD or median (interquartile range) and categorical variables are expressed as either frequency (percentage). ASA = American society of Anesthesiologists, BMI = body mass index, PNX = pneumothorax, SD = standard deviation

LMR values and VAS rest and VAS cough values. However, when compared to the preoperative period, a negative correlation was found between the change in the postoperative LMR value and the VAS rest and VAS cough values in the early postoperative period; this suggests that inflammatory parameters may be effective in evaluating the postoperative pain level. This is the first study to demonstrate the correlation of inflammatory parameters with postoperative pain in VATS patients.

Inadequate pain control may cause a significant increase in postoperative morbidity and/or mortality and negative effects on quality of life.^[25,26] On the other hand, appropriate management of postoperative pain provides early mobilization, fewer systemic complications, shorter hospital stays, lower costs, and increased patient satisfaction.^[23,27–29] Complications—such as postoperative pneumonia and atelectasis—were seen to be reduced with early mobilization of the patients in the postoperative period after thoracic surgery as well as coughing to clear the secretions in the lungs. Therefore, adequate analgesia after thoracic surgery is vital, not only from an ethical point of view, but also to reduce postoperative pulmonary complications.^[30] Appropriate analgesia is only possible with an effective and objective evaluation of postoperative pain.

Table 2
The postoperative complications of the patients.

Patients (n = 105)	n (%)
Postoperative complication	
Hypotension	2 (1.9)
Itching	2 (1.9)
Nausea	2 (1.9)
Vomiting	1 (0.9)
Total	7 (6.6)

Categorical variables are expressed as either frequency (percentage).

Table 3
Preoperative and postoperative laboratory parameters of the patients.

	Median (IQR)		P
	Preoperative	Postoperative	
Lymphocyte (×10 ³ /μl)	1.91 (0.88)	1.40 (0.7)	<.001
Monocyte (×10 ³ /μl)	0.50 (0.27)	0.72 (0.37)	<.001
Neutrophil (×10 ³ /μl)	5.62 (4.37)	9.24 (4.36)	<.001
RDW (%)	13.50 (1.6)	13.30 (1.5)	.002
Platelets (×10 ³ /μl)	264 (104)	238 (100)	<.001
MPV (fl)	9.50 (1.3)	9.30 (1.3)	.014
Neutrophil to lymphocyte ratio	2.96 (2.62)	6.61 (4.89)	<.001
Platelet to lymphocyte ratio	136.25 (81.57)	163.64 (112.59)	<.001
Lymphocyte to monocyte ratio	3.90 (2.24)	1.92 (1.13)	<.001

Continuous variables were expressed as median (IQR).

IQR = interquartile range, MPV = mean platelet volume, RDW = red cell distribution width.

The pain response to surgical stimulation varies from person to person, and it depends on pain threshold in addition to various other factors. However, in current clinical practice, this evaluation is made with subjective scoring, such as VAS. As such, it appears that pain is a subjective phenomenon.^[2,31] As a matter of fact, in our study, although the same analgesic protocol was applied to the patients, the VAS cough value was found to be 0 in some patients and 7 in some patients at the postoperative 1st and 2nd hours. While the median value of VAS cough at the 1st and 2nd postoperative hours is 4, the median values of VAS rest and VAS cough at other hours are below 4, and these results are similar to the studies in the literature.^[32] Only 5 patients (4.8%) stated that they were not satisfied with the results of the applied analgesia protocol. It is very important to expel secretions from the lungs by coughing in order to prevent or reduce pulmonary complications after thoracic surgery. For this reason, multimodal analgesia protocol is applied in our clinic to prevent patients from giving up coughing due to pain. Literature data also suggest multimodal analgesia for postoperative pain management.^[33] Nevertheless, the high 1st and 2nd-hour VAS cough value in some patients can be attributed to the low pain threshold of the patients or the subjective feature of the VAS scoring. Accordingly, studies that include laboratory parameters are carried out in order to objectively predict postoperative pain.^[2]

Table 4
Postoperative VAS rest and VAS cough data of the patients.

	n = 105, median (IQR)		Min–Max
	n	Median (IQR)	
VAS rest			
1st Hour	3 (2)		0–6
2nd Hour	3 (2)		0–6
4th Hour	2 (1)		0–5
8th Hour	2 (2)		0–4
16th Hour	2 (2)		0–4
24th Hour	2 (2)		0–5
VAS cough			
1st Hour	4 (2)		0–7
2nd Hour	4 (2)		0–7
4th Hour	3 (1)		0–6
8th Hour	3 (2)		0–5
16th Hour	3 (2)		0–5
24th Hour	3 (2)		0–6

Continuous variables were expressed as median (IQR) and minimum maximum value.

IQR = interquartile range, VAS = Visual Analog Scale.

Table 5
Relationship between postoperative hemogram values and VAS- Spearman correlation analyzes.

		Lymphocyte	Monocyte	Neutrophil	RDW	Platelets	MPV
VAS rest 1st Hour	<i>r</i>	0.079	0.176	0.234	-0.110	0.038	0.147
	<i>P</i>	.421	.072	.016	.262	.699	.136
VAS rest 2nd Hour	<i>r</i>	0.078	0.203	0.283	-0.106	0.037	0.160
	<i>P</i>	.428	.038	.003	.281	.709	.104
VAS rest 4th Hour	<i>r</i>	0.037	0.159	0.257	-0.112	-0.043	0.116
	<i>P</i>	.707	.105	.008	.255	.663	.240
VAS rest 8th Hour	<i>r</i>	0.015	0.134	0.207	-0.145	-0.023	0.111
	<i>P</i>	.882	.175	.034	.139	.813	.259
VAS rest 16th Hour	<i>r</i>	-0.003	0.089	0.229	-0.115	-0.127	0.114
	<i>P</i>	.973	.364	.019	.244	.195	.247
VAS rest 24th Hour	<i>r</i>	0.027	-0.043	0.089	-0.096	-0.128	0.023
	<i>P</i>	.786	.660	.366	.330	.193	.812
VAS cough 1st Hour	<i>r</i>	0.063	0.202	0.263	-0.137	0.043	0.127
	<i>P</i>	.526	.039	.007	.165	.662	.196
VAS cough 2nd Hour	<i>r</i>	0.043	0.198	0.277	-0.090	0.013	0.166
	<i>P</i>	.662	.043	.004	.362	.898	.091
VAS cough 4th Hour	<i>r</i>	0.035	0.158	0.256	-0.120	-0.054	0.123
	<i>P</i>	.725	.107	.008	.223	.587	.211
VAS cough 8th Hour	<i>r</i>	0.017	0.130	0.200	-0.153	-0.035	0.114
	<i>P</i>	.867	.188	.041	.120	.723	.246
VAS cough 16th Hour	<i>r</i>	0.007	0.087	0.228	-0.124	-0.137	0.129
	<i>P</i>	.947	.378	.019	.208	.165	.190
VAS cough 24th Hour	<i>r</i>	0.024	-0.052	0.083	-0.076	-0.129	0.047
	<i>P</i>	.806	.599	.402	.439	.188	.633

MPV=mean platelet volume, RDW=red cell distribution width ,VAS=Visual Analog Scale.
P-values marked with bold indicate statistically significant *P*-values

By objectively predicting postoperative pain, unnecessary analgesic use can be prevented, early rehabilitation can be provided to patients, discharge time can be shortened, and patient satisfaction can be increased.^[2]

The most important factors in the formation of postoperative pain are the inflammatory response in the surgical area due to surgical trauma and nociceptor sensitivity and hyperalgesia caused by inflammatory mediators.^[2,34] Since the inflammatory process is an important factor in pain formation, inflammatory markers can be considered as a useful parameter in predicting postoperative pain.^[2,25,35] NLR, PLR, and LMR values are considered to be parameters that can determine the prognosis as an indicator of systemic inflammation in patients.^[36-39] However, there are limited studies that investigate the relationship between inflammatory parameters and postoperative pain.^[2,23,25,35] These studies have predominantly focused on the relationship between postoperative pain and NLR.

In a study, it was stated that preoperative NLR is a powerful parameter in predicting acute pain levels after arthroscopic rotator cuff surgery.^[2] In another study conducted with patients who had undergone laparoscopic cholecystectomy, it was stated that postoperative pain could be predicted with preoperative NLR.^[35] In another study, no relationship was found between preoperative NLR and postoperative VAS values after total hip arthroplasty and total knee arthroplasty; however, a significant correlation was found between postoperative NLR and forty-eighth hour VAS values in those who underwent total hip arthroplasty.^[23] In regard to postoperative pain levels after orthognathic surgery, it has been reported that preoperative NLR can be effective in predicting pain levels.^[25] Although studies have been conducted in regard to various surgeries, no studies were found in the literature that examined the correlation

between postoperative pain and inflammatory parameters in patients who underwent thoracotomy or VATS. In addition, no studies were found that examined the relationship between PLR and postoperative pain.

Contrary to the literature data in our study, no relationship was found between preoperative or postoperative NLR and postoperative pain in patients who underwent VATS. In our study, we observed that PLR—which is an inflammatory parameter like NLR—was not associated with postoperative pain in patients who underwent VATS.

LMR is also considered to be an inflammatory parameter, and it was found that preoperative LMR was negatively correlated with postoperative VAS in patients who underwent arthroscopic rotator cuff tear repair.^[37] In our study, however, it was determined that there was no correlation between preoperative and postoperative LMR and postoperative pain, but there was a significant negative correlation between the level of change between preoperative LMR and postoperative LMR and postoperative VAS rest and VAS cough values. In other words, we can predict that the greater the decrease in the postoperative LMR level compared to the preoperative period, the more pain the patient may develop. This suggests that LMR levels can be used as an inflammatory parameter to predict postoperative pain. Larger series studies on this subject may be useful in evaluating the effectiveness of LMR in predicting pain levels.

Studies on postoperative pain and inflammatory parameters have mostly focused on NLR, which is calculated using neutrophil and lymphocyte counts.^[2,23,25,35] It has been reported that the number of neutrophils in the blood increases as a result of the inflammatory response, and the number of lymphocytes decreases; accordingly, there is a change in leukocyte ratios.^[23,24] However, this present study and the Yaying Sun et al study^[37] show that

Table 6
VAS relationship with the change in neutrophil to lymphocyte ratio, platelet to lymphocyte ratio, lymphocyte to monocyte ratio values after surgery compared to preoperatively.

		NLR change according to the preoperative period	PLR change according to the preoperative period	LMR change according to the preoperative period
VAS rest				
1st Hour	<i>r</i>	0.116	0.098	-0.237
	<i>P</i>	.237	.321	.015
2nd Hour	<i>r</i>	0.115	0.066	-0.222
	<i>P</i>	.244	.503	.023
4th Hour	<i>r</i>	0.122	0.005	-0.249
	<i>P</i>	.213	.961	.010
8th Hour	<i>r</i>	0.102	0.017	-0.190
	<i>P</i>	.302	.861	.052
16th Hour	<i>r</i>	0.128	-0.057	-0.239
	<i>P</i>	.193	.561	.014
24th Hour	<i>r</i>	0.071	-0.095	-0.150
	<i>P</i>	.470	.333	.127
VAS cough				
1st Hour	<i>r</i>	0.145	0.087	-0.256
	<i>P</i>	.141	.380	.008
2nd Hour	<i>r</i>	0.155	0.091	-0.242
	<i>P</i>	.115	.357	.013
4th Hour	<i>r</i>	0.127	0.005	-0.253
	<i>P</i>	.197	.960	.009
8th Hour	<i>r</i>	0.107	0.014	-0.201
	<i>P</i>	.276	.888	.040
16th Hour	<i>r</i>	0.131	-0.058	-0.257
	<i>P</i>	.184	.556	.008
24th Hour	<i>r</i>	0.084	-0.082	-0.156
	<i>P</i>	.397	.408	.111

LMR=lymphocyte to monocyte ratio, NLR=neutrophil to lymphocyte ratio, PLR=platelet to lymphocyte ratio, VAS=Visual Analog Scale.
P-values marked with bold indicate statistically significant *P*-values

monocytes are a crucial aspect in regard to postoperative pain. In our study, a significant positive correlation was found between the postoperative monocyte value and the VAS resting and VAS cough values, particularly in the early postoperative period. The negative correlation between the amount of change between preoperative LMR and postoperative LMR and postoperative pain shows that the change in leukocyte rates is also important.

Another parameter that we found to be correlated with postoperative pain is the postoperative neutrophil count. The significant positive correlation between postoperative neutrophils and VAS resting and VAS cough values at different times suggests the importance of inflammation in regard to the pain mechanism. It also suggests that these parameters can be used as markers in pain assessment.

There are some limitations within this study. First, this work is a single-center study. It was performed only once in the early postoperative period by evaluating the laboratory parameters. The relationship between inflammatory parameters and pain can be evaluated in more detail by looking at the changes in laboratory values during different time periods in the postoperative period. Another important limitation is as follows: although the study excludes patients with inflammatory disease and conditions affecting inflammatory parameters, inflammatory parameters such as NLR, PLR, and LMR can be affected by many conditions.

5. Conclusion

When compared to the preoperative period, the change in postoperative neutrophil, postoperative monocytes, and

postoperative LMR values in patients undergoing VATS in thoracic surgery can be used as a guide in the objective evaluation of postoperative acute pain. In addition, we think that unnecessary analgesic use can be prevented and patients can be rehabilitated early, thanks to these inexpensive and easy-to-evaluate parameters. Also, we think that comprehensive new studies on this subject will contribute significantly to the determination of objective criteria in postoperative pain evaluation.

Author contributions

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