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Original Article

Postoperative pain score and infection risk in lung cancer resection: a propensity score-matching study

Hui Liu[1*], Yunpeng Zhang[2*], Wenxing Xia[3], Wei Hu[2]

[1]Department of Infectious Diseases, The 966th Hospital of PLA Joint Logistics Support Force, Dandong 118000, Liaoning, China; [2]Department of TCM Rehabilitation, The 966th Hospital of PLA Joint Logistics Support Force, Dandong 118000, Liaoning, China; [3]Department of Radiology, The 966th Hospital of PLA Joint Logistics Support Force, Dandong 118000, Liaoning, China. [*]Equal contributors.

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Abstract: Objective: To explore the relationship between postoperative pain score and infection after lung cancer resection using propensity score matching. Methods: A retrospective analysis was conducted on 206 cases of malignant lung tumors that underwent surgical resection between September 2022 and October 2025. Patients were divided into a low numerical rating scale (NRS) group (NRS ≤ 3, n = 134) and a high NRS group (NRS > 3, n = 72) based on their postoperative pain scores. A 1:1 propensity score matching was used to balance baseline characteristics, and postoperative pulmonary infection rates were compared. Results: Before matching, there were no significant differences between the low and high NRS groups in terms of gender, age, history of back pain, operation time, incision intercostal width, length of hospital stay, and preoperative psychological status (all $P < 0.05$). After matching, there were no statistically significant differences in these indicators between the two groups (all $P > 0.05$). The postoperative pulmonary infection rate in patients with low NRS scores was 4.88%, lower than the 24.39% in patients with high NRS scores ($P < 0.05$). The visual analog scale (VAS) scores of both groups were significantly lower than those of the high NRS group at 2, 6, and 12 hours postoperatively (all $P < 0.05$), while the overall complication rate was significantly lower in the high-score group ($P < 0.05$). The forced vital capacity (FVC), forced expiratory volume in one second (FEV1), and maximal voluntary ventilation (MVV) levels were significantly lower in the low-score group than those in the high-score group (all $P < 0.05$). Conclusion: There is a certain correlation between postoperative pain score and pulmonary infection after lung cancer resection.

Keywords: Lung cancer resection, the numerical rating scale, postoperative infection, propensity score matching analysis

Introduction

Lung cancer is a malignant tumor, and its clinical manifestations include dyspnea, cough, chest pain, hemoptysis, and weight loss, which have a great impact on the health of patients [1, 2]. Non-small cell lung cancer (NSCLC) is a common type of lung cancer. It is a malignant tumor that originates from the bronchial mucosa, glands, and alveolar epithelium. If it is not treated in time, the mortality rate is high [3, 4]. With the improvement of medical level and the popularization of health check-up concept, the early detection rate of non-small cell lung cancer has been rising, and the overall prognosis has been greatly improved [5-7]. Surgery is the main treatment for early non-small cell lung cancer. By removing the lesion tissue, the progression of malignant tumor can be stopped and the survival time of patients can be extended [8, 9]. However, surgery is an invasive procedure, and the damage to the body tissue during the operation is relatively large. Some patients are prone to chronic pain (CPSP) after surgery [10]. The occurrence of chronic pain not only increases the patient's suffering, but also induces postoperative complications such as atelectasis and secretion retention [11]. In order to alleviate the patient's suffering, nerve root block is used for analgesia in clinical practice. This method has been widely used. Postoperative pain can be relieved and patients' quality of life improved by blocking nerve roots [12, 13]. Currently, although analgesia manage-

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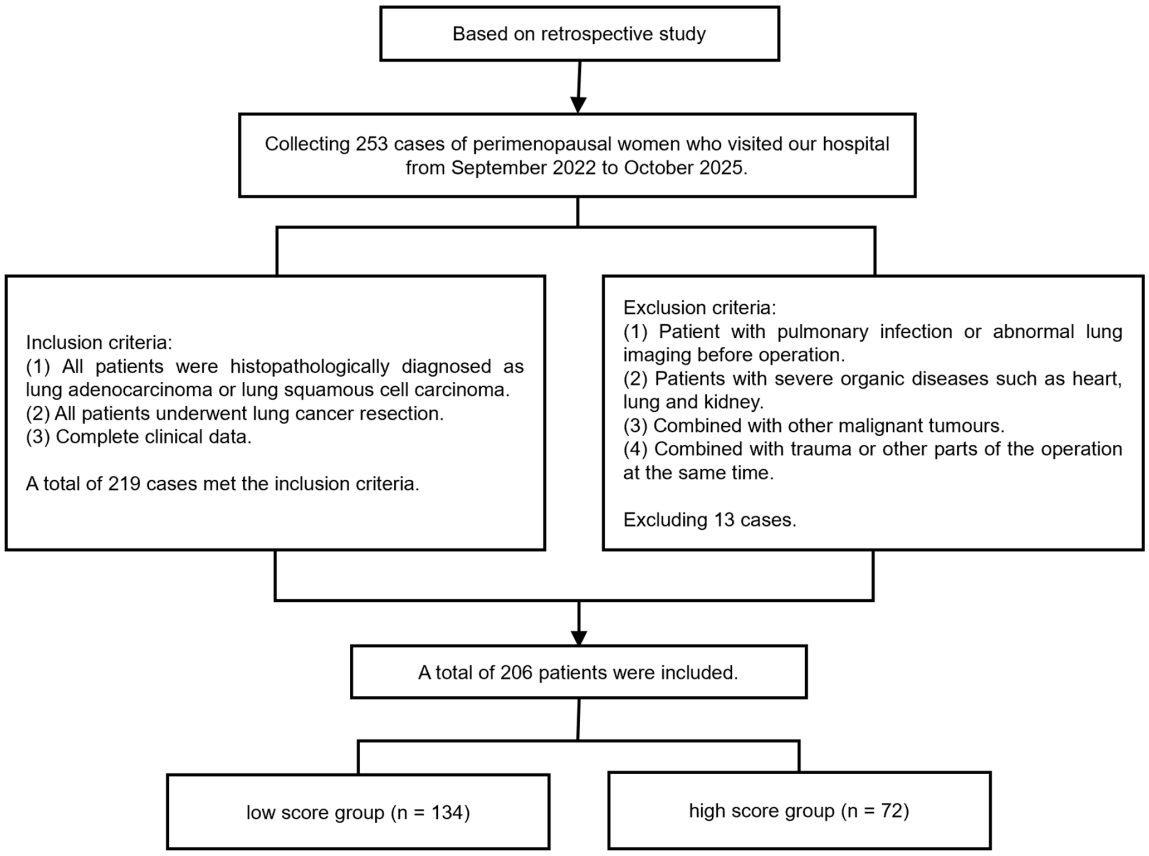

Figure 1. Patient screening flowchart.

ment after lobectomy for non-small cell lung cancer patients has been strengthened clinically, the incidence of chronic pain remains high. Identifying the risk factors for chronic pain and implementing early intervention will help reduce the risk of chronic pain. Meanwhile, previous studies were mostly retrospective observational studies, and confounding factors in some case-control studies have led to significant bias in the results, affecting the reliability of the conclusions. Therefore, this study, based on real data from our hospital's electronic medical record system, used propensity score matching to adjust the data, aiming to clarify the relationship between postoperative pain scores and pulmonary infection after lung cancer resection.

Materials and methods

Subjects

We retrospectively analyzed 206 cases of lung malignant tumors that underwent surgical resection at the 966th Hospital of PLA Joint Logistics Support Force from September 2022 to October 2025. Inclusion criteria: (1) All patients were diagnosed with lung adenocarcinoma or squamous cell carcinoma by histopathology; (2) All patients underwent lung cancer resection; (3) Complete clinical data. Exclusion criteria: (1) Patients with preoperative pulmonary infection or abnormal pulmonary imaging; (2) Patients with severe organic diseases of the heart, lungs, kidneys, etc.; (3) Patients with other malignant tumors; (4) Patients with concurrent trauma or surgery on other sites. This study was approved by the Ethics Committee of the 966th Hospital of PLA Joint Logistics Support Force. Due to the retrospective study design, informed consent was not required. See **Figure 1**.

Data collection

Factors influencing postoperative infection in lung cancer patients were collected, including gender, age, body mass index (BMI), alcohol

consumption history, history of hypertension, history of diabetes, preoperative history of chest and back pain, TNM stage, pathological type, surgical side, operation time, intraoperative blood loss, incision intercostal width, intraoperative use of hormones, intraoperative use of nonsteroidal anti-inflammatory drugs (NSAIDs), length of hospital stay, preoperative psychological state, hemoglobin, albumin, blood glucose, alanine aminotransferase (ALT), aspartate aminotransferase (AST), and total bilirubin. The incidence of postoperative complications (air leak, atelectasis, respiratory failure) was recorded, and pulmonary function levels [forced expiratory volume in one second (FEV1), forced vital capacity (FVC), and maximum voluntary ventilation (MVV)] were compared.

Diagnostic criteria for postoperative

Postoperative pulmonary infection is diagnosed according to the former Ministry of Health's "Diagnostic Criteria for Hospital Infection (Trial Implementation)": (1) Recent onset of cough and sputum production, with moist rales heard on lung auscultation, accompanied by any of the following: a. Fever, with a body temperature exceeding 38°C; b. Abnormally elevated or decreased white blood cell count; c. Chest imaging showing inflammatory lesions. (2) Acute infection secondary to chronic airway disease, with changes in pathogens or new lesions shown on chest imaging. Meeting any one of (1) or (2) is sufficient for a diagnosis of postoperative pulmonary infection.

Pain score and grouping

Within 24 hours of returning to the ward from the anesthesia recovery room, pain is quantified using a 0-10 numerical rating scale: 0 indicates no pain, and 10 indicates the most intense imaginable pain. 1-3, 4-6, and 7-10 are defined as mild, moderate, and severe pain, respectively; mild discomfort does not affect sleep, while higher scores indicate greater interference with rest. Visual analog scale (VAS) scores were recorded at 2, 6, 12, and 24 hours, with peak values retained. Based on this, 134 patients whose digit rating scale (NRS) scores never exceeded 3 were assigned to the low NRS group, and the remaining 72 patients were assigned to the high NRS group.

Propensity score matching

To eliminate the influence of confounding factors on the research results, this study employed caliper matching in propensity score matching. First, propensity scores were calculated using a statistical model, and a low-NRS and high-NRS groups were distinguished based on the grouping variable. A matching tolerance, i.e., the caliper value, was set. Second, individuals in the high-NRS group were randomly ranked, and the first individual selected from the high-NRS group was compared with the propensity scores of all individuals in the low-NRS group. Individuals whose propensity scores differed within the caliper value range were paired, while those whose propensity scores differed outside the caliper value range were discarded. If two or more individuals in the low-NRS group had propensity scores within the caliper value range of an individual in the high-NRS group, they were randomly selected. Finally, after confirming each match, the paired cases were removed from the register, and the process was repeated for the next study subject until no unmatched individuals remained. This study used propensity score matching to perform a 1:1 match between low- and high- NRS groups. Matching factors included gender, age, history of back pain, operation time, intercostal width of incision, length of hospital stay, and preoperative psychological state. The caliper value was set at 0.02. A total of 41 patients with low NRS scores and 41 patients with high NRS scores were successfully matched.

Statistical analysis

All analyses were performed using IBM SPSS 23.0 software. Normally distributed continuous variables were expressed as mean ± standard deviation. Two-sample t-tests were used for comparisons between groups. Chi-square tests were used for categorical data. A two-sided p-value ≤ 0.05 was considered statistically significant.

Results

Univariate analysis of postoperative pain after lung cancer resection

Statistically significant differences were found between the low NRS group and the high NRS

Table 1. Univariate analysis of pain after lung cancer resection

Index	Low NRS group (n = 134)	High NRS group (n = 72)	χ^2/t	*P*
Gender			6.714	0.010
Male	68 (50.75)	23 (31.94)		
Female	66 (49.25)	49 (68.06)		
Age (years)	43.61±5.34	45.81±5.73	2.741	0.007
BMI (kg/m^2)	21.52±1.05	21.62±1.09	0.648	0.518
Drinking	19 (14.18)	7 (9.72)	0.844	0.358
Hypertension	65 (48.51)	33 (45.83)	0.134	0.714
Diabetes	28 (20.90)	17 (23.61)	0.202	0.653
Preoperative chest and back pain	34 (25.37)	9 (12.50)	4.699	0.030
TNM			0.113	0.737
I-II	74 (55.22)	38 (52.78)		
III-IV	60 (44.78)	34 (47.22)		
Pathological type			2.210	0.137
Adenocarcinoma	49 (36.57)	34 (47.22)		
Squamous carcinoma	85 (63.43)	38 (52.78)		
Surgical side			0.912	0.340
Left	38 (28.36)	16 (22.22)		
Right	96 (71.64)	56 (77.78)		
Operation time (min)	133.49±8.54	139.24±8.72	4.571	< 0.001
Intraoperative blood loss (mL)	214.13±25.77	218.29±26.44	1.094	0.275
Incision costal space width (cm)			6.314	0.012
< 1.5	81 (60.45)	56 (77.78)		
≥ 1.5	53 (39.55)	16 (22.22)		
Intraoperative use of hormones	48 (35.82)	24 (33.33)	0.127	0.721
Intraoperative use of NSAIDs	57 (42.54)	36 (50.00)	1.053	0.305
Hospitalization time (d)	11.69±2.11	9.35±1.65	-8.168	< 0.001
Preoperative psychological status			6.042	0.014
Good	102 (76.12)	43 (59.72)		
Poor	32 (23.88)	29 (40.28)		
Hemoglobin ($\bar{x}$±sd, g/L)	136.22±30.49	130.79±32.31	-1.195	0.233
Albumin ($\bar{x}$±sd, ×g/L)	37.18±9.96	37.42±10.68	0.163	0.871
Blood glucose ($\bar{x}$±sd, mmol/L)	5.77±1.80	5.54±1.69	-0.909	0.365
ALT ($\bar{x}$±sd, U/L)	34.62±10.15	37.48±10.69	1.893	0.060
AST ($\bar{x}$±sd, U/L)	32.85±9.77	35.11±10.18	1.557	0.121
Total bilirubin ($\bar{x}$±sd, μmol/L)	10.80±3.28	11.56±3.43	1.559	0.121

NRS, numerical rating scale; BMI, body mass index; ALT, alanine transaminase; AST, aspartate aminotransferase.

group in terms of gender, age, history of back pain, operation time, incision intercostal width, length of hospital stay, and preoperative psychological state (all P < 0.05). See **Table 1**.

Multivariate analysis of postoperative pain after lung cancer resection

Postoperative pain intensity was used as the dependent variable, where "1" represents the high NRS group and "0" represents the low NRS group. Indicators marked as significant in the univariate assessment were included in the multivariate logistic regression analysis (**Table 2**).

Multivariate logistic regression analysis showed that age, operation time, length of hospital stay, and preoperative psychological state were influencing factors for postoperative pain after lung cancer resection (P < 0.05). See **Table 3**.

Table 2. Variable assignment

Index	Assignment method
Gender	1 = Male, 0 = Female
Age	Entry of actual values
Preoperative chest and back pain	1 = Yes, 0 = No
Operation time	Entry of actual values
Incision costal space width	1 = <1.5 cm, 0 = ≥1.5 cm
Hospitalization time	Entry of actual values
Preoperative psychological status	1 = Good, 0 = Poor

Baseline balance between matched low and high NRS groups

After propensity score adjustment, there were no significant differences in baseline characteristics and multivariate forest plot estimates in NRS scores ($P > 0.05$), indicating that the two groups were balanced based on propensity score matching. See **Table 4** and **Figure 2.**

Postoperative pulmonary infection rates before and after PSM across NRS groups

Before matching, the incidence of postoperative pulmonary infection in the low NRS group and the high NRS group was 17.16% (23/134) and 25.00% (18/72), respectively ($P > 0.05$). After matching, the incidence of postoperative pulmonary infection in patients with low NRS scores was 4.88% (2/41), which was significantly lower than the 24.39% (10/41) in patients with high NRS scores ($P < 0.05$). See **Figure 3**.

VAS pain scores at different time points after surgery in different treatment groups

Postoperative pain levels assessed by the VAS were compared between the low NRS and high NRS groups. Pain intensity recorded at 2 hours (6.51±0.68), 6 hours (3.88±0.81), and 12 hours (2.68±0.72) postoperatively in the low NRS group was significantly lower than that in the high NRS group (2 hours: 6.20±0.68; 6 hours: 4.44±0.71; 12 hours: 3.05±0.67) ($P < 0.05$). In contrast, there was no significant difference in VAS scores between the two groups at 24 hours (low NRS group: 2.00±0.45 vs. high NRS group: 2.17±0.44, $P = 0.086$), as illustrated in **Figure 4**.

Group-based complication assessment

Comparative analysis of postoperative complications (including air leak, atelectasis, and respiratory failure) showed a statistically significant reduction in the overall complication rate in the high NRS group compared to the low NRS group ($\chi^2 = 5.750$, $P = 0.016$). These findings are summarized in **Table 5**.

Pulmonary function assessment in each treatment group

Postoperative assessment showed significant decreases in pulmonary function parameters in both groups compared to baseline preoperative values. Specifically, in the low NRS group, FVC decreased from 2.58±0.22 to 2.06±0.14, FEV1 decreased from 2.68±0.11 to 1.87±0.21, and MVV decreased from 76.70±4.70 to 63.07±6.10. Similarly, the high-score group also showed a decrease in FVC (from 2.56±0.37 to 2.12±0.14), FEV1 (from 2.70±0.15 to 2.15±0.10), and MVV (from 77.52±5.86 to 70.64±5.64).

Comparative analysis indicated that the low-score group experienced a more significantly impaired recovery of lung function. The low-score group had significantly lower FVC, FEV1, and MVV values than the high-score group, with a *P*-value of 0.042 for FVC (2.06±0.14 vs. 2.12±0.14), $P < 0.001$ for FEV1 (1.87±0.21 vs. 2.15±0.10), and $P < 0.001$ for MVV (63.07±6.10 vs. 70.64±5.64). These results are summarized in **Figure 5**.

Discussion

Pain refers to the painful stimulation process caused by various injuries such as surgery, lesions, and inflammation. This stimulation originates from the site of trauma or lesion and is transmitted to the central nervous system through peripheral nerves, thereby producing a feeling of pain [14]. Lung cancer resection is a complex procedure with significant surgical trauma, which can easily lead to severe postoperative pain, affecting the patient's rest and sleep, increasing the patient's suffering and psychological burden, and causing dysfunction of important organs, including delayed recovery of gastrointestinal function, coagulation dysfunction, cardiopulmonary dysfunction, and neuroendocrine dysfunction, which in turn can lead to various complications [15-17]. After resection of malignant lung tumors, lung infection often occurs and has a significant impact on the patient's prognosis. The clinical symp-

Table 3. Multivariate analysis of pain after lung cancer resection

Index	B	SE	Wald	*P*	OR	95% CI
Gender	-0.515	0.385	1.792	0.181	0.598	0.281-1.270
Age	0.103	0.035	8.737	0.003	1.109	1.035-1.188
Preoperative chest and back pain	-0.336	0.485	0.478	0.489	0.715	0.276-1.851
Operation time	0.075	0.022	11.977	0.001	1.078	1.033-1.125
Incision costal space width	0.348	0.412	0.714	0.398	1.416	0.632-3.174
Hospitalization time	-0.589	0.112	27.438	< 0.001	0.555	0.445-0.692
Preoperative psychological status	-0.881	0.403	4.773	0.029	0.414	0.188-0.913
Constant	-8.646	3.695	5.475	0.019	0.001	-

SE, standard error; OR, odds ratio; CI, confidence interval.

Table 4. Comparison of baseline characteristics between the two groups after PSM

Index	Low NRS group (n = 41)	High NRS group (n = 41)	χ^2/t	*P*
Gender			0.449	0.503
Male	16 (39.02)	19 (46.34)		
Female	25 (60.98)	22 (53.66)		
Age (years)	45.34±5.74	44.32±4.91	-0.869	0.388
BMI (kg/m^2)	21.47±1.12	21.69±1.06	0.943	0.349
Drinking	7 (17.07)	3 (7.32)	1.822	0.177
Hypertension	25 (60.98)	19 (46.34)	1.766	0.184
Diabetes	7 (17.07)	10 (24.39)	0.668	0.414
Preoperative chest and back pain	9 (21.95)	6 (14.63)	0.734	0.391
TNM			0.049	0.824
I-II	23 (56.10)	22 (53.66)		
III-IV	18 (43.90)	19 (46.34)		
Pathological type			0.781	0.377
Adenocarcinoma	18 (43.90)	22 (53.66)		
Squamous carcinoma	23 (56.10)	19 (46.34)		
Surgical side			1.713	0.191
Left	12 (29.27)	7 (17.07)		
Right	29 (70.73)	34 (82.93)		
Operation time (min)	136.76±8.64	137.78±8.93	0.528	0.599
Intraoperative blood loss (mL)	213.71±23.49	218.85±27.62	0.909	0.366
Incision costal space width (cm)			< 0.001	1.000
< 1.5	29 (70.73)	29 (70.73)		
≥ 1.5	12 (29.27)	12 (29.27)		
Intraoperative use of hormones	17 (41.46)	14 (34.15)	0.467	0.494
Intraoperative use of NSAIDs	16 (39.02)	21 (51.22)	1.231	0.267
Hospitalization time (d)	9.98±1.78	9.90±1.48	-0.202	0.840
Preoperative psychological status			0.053	0.817
Good	27 (65.85)	26 (63.14)		
Poor	14 (34.15)	15 (36.59)		
Hemoglobin ($\bar{x}$±sd, g/L)	131.19±28.64	133.27±35.02	0.295	0.769
Albumin ($\bar{x}$±sd, ×g/L)	37.64±11.24	36.14±10.36	-0.628	0.532
Blood glucose ($\bar{x}$±sd, mmol/L)	5.64±1.78	5.40±1.77	-0.608	0.545
ALT ($\bar{x}$±sd, U/L)	34.03±9.47	36.92±11.99	1.212	0.229
AST ($\bar{x}$±sd, U/L)	33.30±9.90	34.17±10.25	0.393	0.695
Total bilirubin ($\bar{x}$±sd, μmol/L)	11.32±3.29	11.55±3.46	0.318	0.751

NRS, numerical rating scale; BMI, body mass index; ALT, alanine transaminase; AST, aspartate aminotransferase.

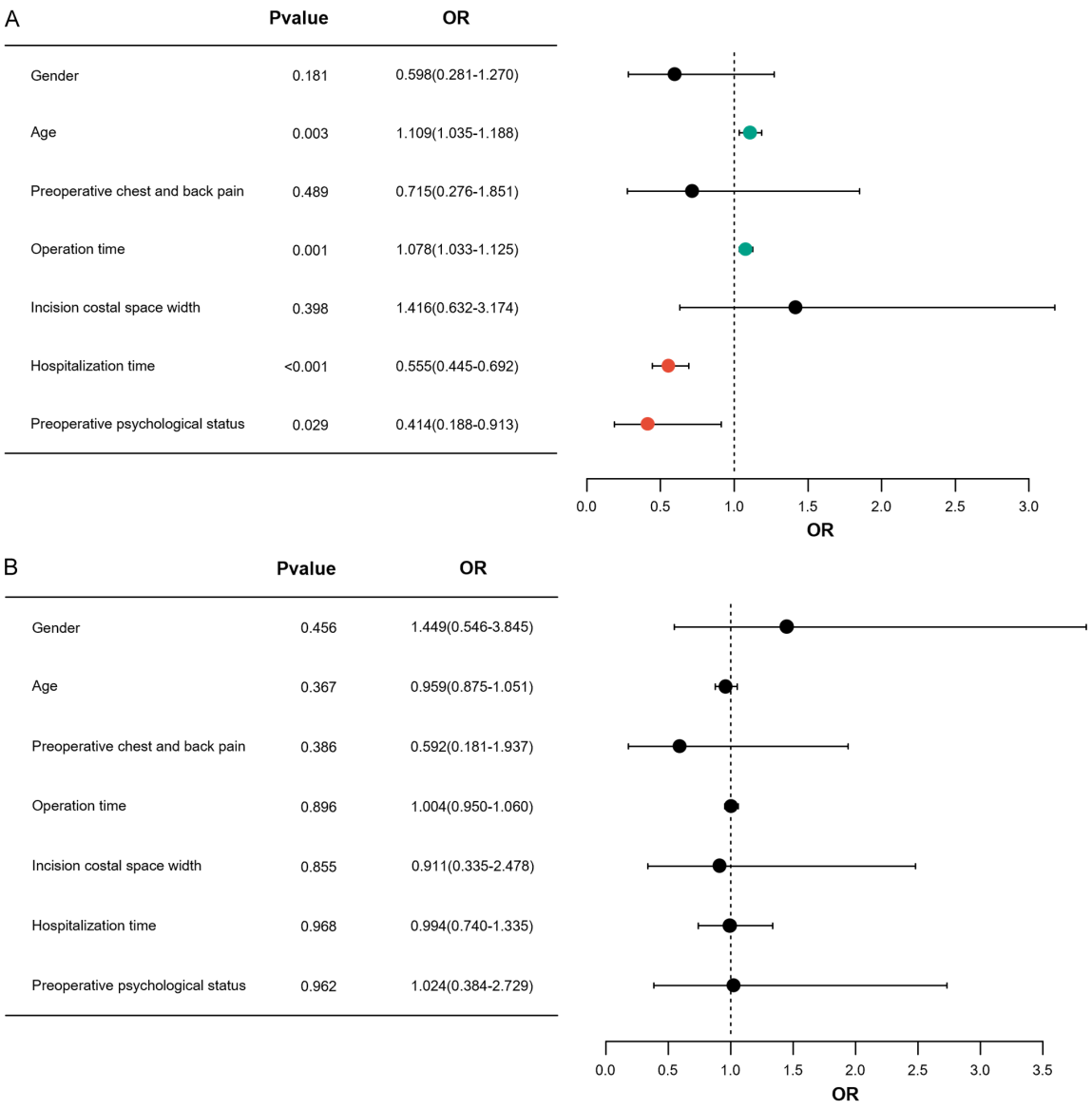

Figure 2. Forest plot of multi-factor analysis before and after propensity score matching (PSM). A. Before PSM; B. After PSM. OR, odds ratio.

toms of postoperative lung infection vary from person to person and are diverse, with high fever being a common manifestation. Infection can induce cough and expectoration. At this time, the sputum is viscous, which leads to poor expectoration, which in turn aggravates respiratory distress, causing complications such as bronchial obstruction and atelectasis, and may even cause suffocation due to airway obstruction by sputum [18]. Postoperative pain is a key and unavoidable problem after lung cancer resection, which is particularly prominent in elderly patients. This population often has weakened immune function and reduced tissue repair capacity, making them more susceptible to significant postoperative stress responses, thus hindering the recovery process. Pain itself stems from multiple sources: surgical trauma, as a strong and harmful stimulus, triggers the release of inflammatory mediators, including cytokines such as potassium ions, bradykinin, prostaglandins, and interleukins; simultaneously, direct damage to the intercostal nerves, muscles, and pleura causes severe, localized pain. As a major postoperative stressor, severe pain activates the renin-angiotensin-aldosterone system (RAAS), leading to elevated blood pressure, which may

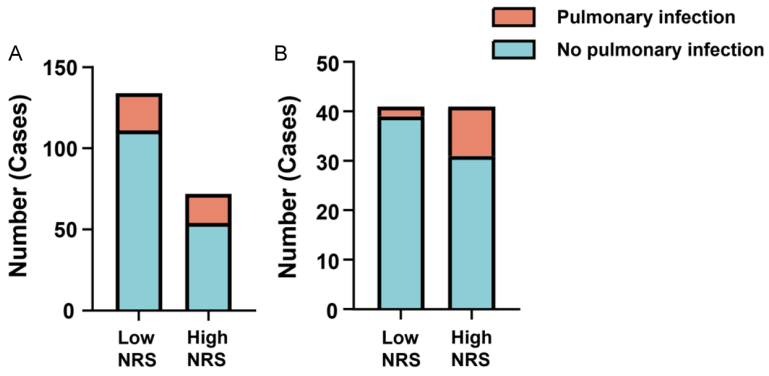

Figure 3. Comparison of the incidence of postoperative pulmonary infection between NRS low and high score group before and after propensity score matching (PSM). A. Before PSM; B. After PSM. NRS, numerical rating scale.

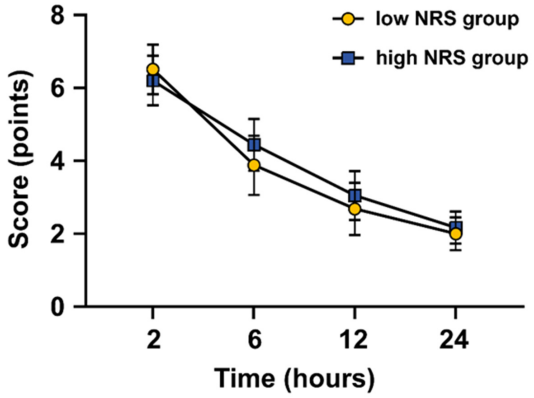

Figure 4. Comparison of VAS scores between the two groups at different time points after the operation. NRS, numerical rating scale; VAS, Visual Analogue Scale.

trigger a series of complications and increase the risk of infection.

Studies have shown that poor postoperative pain control can exacerbate the body's stress response, stimulate hormone release and sympathetic nerve excitation, ultimately leading to changes in patients' vital signs, mental state, and organ function, and increasing the risk of postoperative infection [19]. However, there are many clinical factors contributing to pulmonary infection after lung cancer resection, and previous studies were mostly retrospective, often failing to consider the impact of various factors caused by postoperative pain on postoperative pulmonary infection. Therefore, such studies lack rigor, and their conclusions are controversial [20-22]. To address this, our study introduced propensity score matching to try to balance the influence of these biases and confounding factors between the two groups of patients, clarifying the relationship between postoperative pain and pulmonary infection after lung cancer resection.

Nerve root block is an interventional treatment method. Under ultrasound guidance, the treatment solution is precisely injected around the diseased nerve root. The nonsteroidal anti-inflammatory drugs, local anesthetics, and neurotrophic drugs in the treatment solution can effectively reduce inflammation around the nerve root, block pain transmission, improve the nutritional status of the nerve root, and regulate the excitability of the ganglion, thereby significantly relieving the patient's pain [23, 24]. Evidence from univariate and multivariate statistical analyses suggests that age, surgical time, hospital stay, and preoperative psychological state are influencing factors for postoperative pain after lung cancer resection. Younger patients tend to have a better mindset when facing surgical pain and are more likely to alleviate pain by diverting their attention [25]. Surgical time is a significant risk factor for postoperative pain because longer surgical time may lead to increased tissue damage and inflammatory response, resulting in more severe pain [26]. Longer hospital stays are often associated with more severe conditions and greater anxiety. Psychological anxiety can affect pain perception and treatment mechanisms, thereby increasing the risk of postoperative pain [27]. Therefore, during lung cancer resection, surgical time should be minimized and measures should be taken to alleviate the patient's psychological stress.

Before matching, there were significant differences in some baseline data. There was no significant difference in the incidence of postoperative pulmonary infection between the low NRS group and the high NRS group. After matching, there was no significant difference in the baseline data between the two groups, suggesting that the baseline data of the two groups reached equilibrium after matching ba-

Table 5. Comparison of complications between the two groups

Group	Pulmonary air leaks	Pulmonary atelectasis	Respiratory failure	Total
low NRS group (n = 41)	0	0	0	0
high NRS group (n = 41)	3	1	0	4
χ^2				5.750
P				0.016

NRS, numerical rating scale.

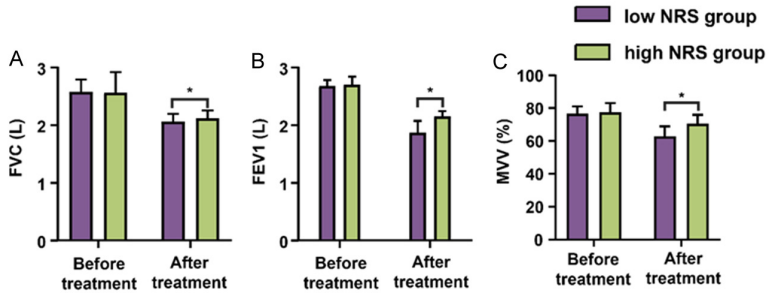

Figure 5. Comparison of lung function between the two groups. A. FVC; B. FEV1; C. MVV. * $P < 0.05$. FEV1, forced expiratory volume in one second; FVC, forced expiratory volume; MVV, maximum ventilation.

The results of this study indicate that severe postoperative pain significantly increases the risk of complications and abnormal pulmonary function indicators after lung cancer resection. Therefore, in clinical practice, postoperative pain should be actively assessed, and analgesic interventions should be given as early as possible to eliminate or reduce pain. For example, a pillow should be placed under the patient before they regain consciousness; after they regain consciousness and their vital signs are stable, a semi-recumbent position can increase lung ventilation, reduce incision tension, relieve pain, and also help the patient turn over, pat their back, etc., promoting expectoration of sputum [32].

sed on propensity score. After matching, the incidence of postoperative pulmonary infection was lower in the low NRS score group, suggesting that severe postoperative pain increases the risk of pulmonary infection after lung cancer resection. Postoperative pain can lead to cough disorder, reduce deep breathing, expectoration and other activities, and the inability to expel sputum leads to sputum deposition, which provides a good condition for bacterial growth. Pathogen colonization secretions enter the lower respiratory tract and cause pulmonary infection [28]. In addition, severe pain can promote the body's inflammatory response, aggravate the stress response, and increase the risk of pulmonary infection [29]. The reason for the significant differences before and after matching is that there are many confounding factors in previous studies. When comparing the baseline data of patients, they may have statistical differences, but they are often overlooked, while these variables usually have a greater impact on the research results. Propensity score matching is a very practical statistical method that uses non-randomized controlled data to assess the effects of intervention or exposure factors on outcomes, balancing covariates between groups and reducing the influence of confounding factors [30, 31]. Limitations of this study: As a retrospective analysis, despite propensity score matching, unavoidable selection bias still exists between the two groups; due to the single-center design, these results need to be validated through large-scale, multi-center prospective studies.

Conclusion

In summary, postoperative pain scores after lung cancer resection are correlated with pulmonary infection. Severe postoperative pain increases the risk of postoperative pulmonary infection in patients undergoing lung cancer resection. Therefore, postoperative pain should be actively assessed, and all patients should receive preoperative pain scoring education. The NRS scoring criteria and self-reporting process should be clearly defined, emphasizing the dangers of high pain and improving the timeliness of postoperative pain feedback. NRS scores should be recorded every 2 hours for all patients within the first 24 hours postoperatively. If the NRS score exceeds 3, intervention should be initiated immediately to prevent persistent pain from triggering a stress response, thereby inhibiting the occurrence of pulmonary infections.

Disclosure of conflict of interest

None.

Address correspondence to: Wei Hu, Department of TCM Rehabilitation, The 966th Hospital of PLA Joint Logistics Support Force, No. 19, Shijing Street, Zhenxing District, Dandong 118000, Liaoning, China. Tel: +86-04152357364; E-mail: huwei2337875@sina.com; Wenxing Xia, Department of Radiology, The 966th Hospital of PLA Joint Logistics Support Force, No. 19, Shijing Street, Zhenxing District, Dandong 118000, Liaoning, China. Tel: +86-04152357292; E-mail: wenxing_xia@163.com

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