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Application and Effect Analysis of Single-port and Multi-port Thoracoscopic Techniques in Lung Cancer Surgery

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Abstract: *Objective*: To evaluate the difference in efficacy between single-port and multi-port thoracoscopic techniques for lung cancer surgery. *Methods*: 82 patients with lung cancer who were admitted to the hospital between February 2023 and February 2025 and underwent lobectomy were selected. They were randomly divided into two groups using a random number table. The experimental group underwent single-port thoracoscopic surgery, while the control group underwent multi-port thoracoscopic surgery. The efficacy and other indicators were compared between the two groups. *Results*: There was no difference in the total effective rate between the two groups ($P > 0.05$). The operation time of the experimental group was longer than that of the control group, and the intraoperative blood loss was less than that of the control group. On days 1 and 3 postoperatively, the pain scores of the experimental group were lower than those of the control group. Two months postoperatively, the short-term quality of life score of the experimental group was higher than that of the control group ($P < 0.05$). *Conclusion*: Performing single-port thoracoscopic surgery for lung cancer patients can reduce intraoperative blood loss, relieve postoperative pain symptoms, and improve short-term quality of life. However, the operation time is longer, and it requires higher technical requirements for the operator.

Keywords: Single-port thoracoscopic technique; Multi-port thoracoscopic technique; Lung cancer surgery; Perioperative indicators; Short-term quality of life

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1. Introduction

Lung cancer is a common malignant tumor of the respiratory system, and its causes include environmental changes, irregular work and rest, and long-term smoking. In the early stages of the disease, patients may not have obvious symptoms, and regular physical examinations are the main means of detecting early lung cancer. Therefore, it is easy to miss the opportunity for early treatment [1,2]. Surgical operation is a commonly used method for lung cancer, which can remove the lung lobe to eliminate cancer cells and prolong the patient's survival time. Endoscopic technology is a new method for lobectomy, which can accurately perform surgical treatment. At this

stage, both single-port and multi-port thoracoscopy are minimally invasive techniques for lung cancer surgery. The former completes the surgical operation through a single port, while the latter requires two or more small holes. Although their surgical principles are the same, their surgical effects are different. Therefore, this study selected 82 patients with lung cancer to evaluate the effectiveness of single-port and multi-port thoracoscopic surgery.

2. Materials and methods

2.1. General information

Eighty-two patients who underwent lobectomy from February 2023 to February 2025 were selected. They were randomly divided into two groups using a random number table. The experimental group consisted of 41 patients, including 25 males and 16 females, aged between 32 and 82 years old, with a mean age of (52.16 ± 3.74) years old. The tumor diameter ranged from 1.06 to 2.41 centimeters, with a mean diameter of (1.85 ± 0.64) cm. The control group consisted of 41 patients, including 27 males and 14 females, aged between 30 and 84 years old, with a mean age of (52.35 ± 3.70) years old. The tumor diameter ranged from 1.01 to 2.45 cm, with a mean diameter of (1.91 ± 0.69) cm. There was no significant difference in data between the two groups ($P > 0.05$).

Inclusion criteria: (1) Diagnosed with lung cancer after percutaneous lung biopsy before surgery; (2) Met the indications for lobectomy; (3) Met the indications for endoscopic treatment; (4) Able to tolerate surgical treatment; informed consent for the study.

Exclusion criteria: (1) History of thoracic surgery; (2) Communication disorders; (3) Abnormal heart, liver, and kidney function; (4) Distant metastasis of the lesion; mental illness; (5) Withdrawal in the middle of the study.

2.2. Methods

The control group underwent multi-port thoracoscopic surgery: general anesthesia was administered, and patients were positioned in a lateral decubitus position. An incision of 1 cm was made between the 7th and 8th ribs in the axillary midline region, serving as the observation port for the thoracoscope. Another incision of 3 to 4 cm was made between the 4th ribs in the anterior axillary line region, serving as the main operating port. A 1 cm incision was made between the 6th ribs in the posterior axillary line region, serving as the auxiliary operating port. The thoracoscope was inserted into the chest cavity at a 30° angle, and wedge resection was performed to appropriately remove the lesion. Intraoperative pathological examination was conducted, and lobectomy was performed if lung cancer was confirmed. An ultrasonic knife was used to clean the lymph nodes and stop bleeding quickly. After ensuring no bleeding, a drainage tube was placed in the observation port.

The experimental group underwent single-port thoracoscopic surgery. After anesthesia, patients were positioned in a lateral decubitus position. An incision of 3 to 4 cm was made between the 4th ribs in the anterior axillary region, and the thoracoscope was placed at a 30° angle to fully explore the lung cancer lesion. After locating the lesion, endoscopic staplers were used to perform wedge resection of the lesion tissue. Lobectomy was performed after pathological confirmation, followed by subsequent operations similar to the control group.

2.3. Observation indicators

(1) Perioperative indicators: Observe multiple indicators such as operation time and hospital stay.

(2) Pain score: Use the Visual Analog Scale (VAS) to evaluate pain before surgery, 1 day and 3 days after surgery. The score ranges from 0 to 10, with a higher score indicating greater pain.

(3) Short-term quality of life score: Use the Functional Assessment of Cancer Therapy-Lung (FACT-L) scale,

which includes daily activities (7 items), social/family life (7 items), emotions (6 items), and physical ability (7 items). Each item is scored from 0 to 4, with a higher score indicating a better short-term quality of life.

2.4. Statistical analysis

Data processing was performed using SPSS 28.0 software. Measurement values were compared and tested using t-values, while count values were compared and tested using chi-square values. The criterion for statistical significance was set at $P < 0.05$.

3. Results

3.1. Comparison of perioperative indicators between the two groups

The operation time of the experimental group was longer than that of the control group, while the intraoperative blood loss was less ($P < 0.05$). There were no differences in other perioperative indicators between the two groups ($P > 0.05$) (**Table 1**).

Table 1. Comparison of perioperative indicators between the two groups [mean ± standard deviation (SD)]

Group	*n*	Operative time (min)	Intraoperative blood loss (mL)	Drain retention duration (days)	Hospital stay (days)	Lymph nodes dissected (*n*)
Test group	41	137.53 ± 8.65	671.59 ± 18.52	3.54 ± 0.77	7.21 ± 1.39	14.53 ± 2.54
Control group	41	122.05 ± 8.32	742.68 ± 19.04	3.71 ± 0.82	7.28 ± 1.43	15.01 ± 2.63
t-value		8.259	17.138	0.968	0.225	0.841
P-value		< 0.001	< 0.001	0.336	0.823	0.403

3.2. Comparison of pain scores between the two groups

There was no difference in pain scores between the two groups before surgery ($P > 0.05$). However, the pain scores of the experimental group were lower than those of the control group at 1 and 3 days after surgery ($P < 0.05$) (**Table 2**).

Table 2. Comparison of pain scores between the two groups (mean ± SD, points)

Group	*n*	Pre-op	Post-op Day 1	Post-op Day 3
Test group	41	4.42 ± 0.58	1.79 ± 0.53	0.97 ± 0.27
Control group	41	4.45 ± 0.61	2.90 ± 0.59	1.71 ± 1.08
t-value		0.228	8.962	4.256
P-value		0.820	< 0.001	< 0.001

3.3. Comparison of short-term quality of life scores between the two groups

There was no difference in short-term quality of life scores between the two groups before surgery ($P > 0.05$). However, the short-term quality of life score of the experimental group was higher than that of the control group at 2 months after surgery ($P < 0.05$) (**Table 3**).

Table 3. Comparison of short-term quality of life scores between the two groups (mean ± SD, points)

Group	*n*	Daily activities		Social/Family life		Emotion		Mobility	
		Pre-op	Post-op	Pre-op	Post-op	Pre-op	Post-op	Pre-op	Post-op
Test	41	12.23 ± 2.64	20.15 ± 2.43	17.65 ± 2.10	22.51 ± 1.42	10.25 ± 1.53	19.32 ± 2.84	17.53 ± 2.16	23.25 ± 1.76
Control group	41	12.29 ± 2.60	17.37 ± 2.40	17.61 ± 2.13	20.15 ± 1.30	10.21 ± 1.62	16.52 ± 2.77	17.51 ± 2.23	21.05 ± 1.68
t-value		0.104	5.212	0.086	7.849	0.115	4.519	0.041	5.790
p-value		0.918	<0.001	0.932	<0.001	0.909	<0.001	0.967	<0.001

4. Discussion

Lung cancer, originating from the bronchial epithelial or alveolar epithelial cells, is a common malignant tumor of lung tissue. Its common pathological types are small cell lung cancer and non-small cell lung cancer. Early stages of the disease often present no obvious symptoms, and risk factors include air pollution and long-term smoking. Surgical resection, especially lobectomy combined with lymph node dissection, is frequently performed for patients with this disease. This surgical approach can completely remove the tumor lesion, halt disease progression, prevent distant metastasis of the tumor, and prolong the patient's survival.

Multi-port thoracoscopic surgery is a commonly used minimally invasive technique for lobectomy, providing a broad surgical field of view, avoiding obscuration, detecting occult lesions, and improving surgical success rates [3]. Additionally, multi-port thoracoscopy enables comprehensive lymph node dissection, facilitating easier surgical operations and higher treatment feasibility. However, lung cancer patients often have low immunity and a hypercoagulable blood state, leading to average tolerance for surgical treatment. Multi-port thoracoscopic surgery requires three incisions, which can be more traumatic to the patient's body and result in longer incision healing times, hindering early postoperative recovery. To fully leverage the advantages of minimally invasive treatment, single-port thoracoscopic technology has been widely implemented. This technique requires only one incision, providing a clear and open surgical field that allows for multi-angle evaluation of tumor lesions using the thoracoscope. The simplified surgical procedure enables precise lesion removal with high surgical safety.

Results indicate that both single and multi-port thoracoscopy can rapidly locate tumor lesions using high-definition cameras to observe the thoracic cavity and collect pathological tissue using a wedge resection method, followed by targeted lobectomy. The operating principles and resection scope of the two techniques are largely consistent, resulting in similar surgical efficacy. The experimental group exhibited a longer surgical time and less intraoperative blood loss compared to the control group ($P < 0.05$). This difference is attributed to the limited operating space during single-port thoracoscopic surgery, where all procedures are completed through a single incision without additional assistance, increasing surgical difficulty and requiring higher precision. Consequently, operators need to be more cautious and meticulous, thus prolonging the operation time [4,5]. However, single-port surgery reduces bleeding from multiple incisions, minimizes interference with intrathoracic organs, and decreases intraoperative blood loss. At 1 and 3 days postoperatively, the pain scores of the experimental group were lower than those of the control group ($P < 0.05$). This difference arises from the reduced number of incisions in single-port thoracoscopy, with a single incision length of 3 to 4 centimeters, alleviating postoperative incision pain. Moreover, the incision location in single-port surgery is at the anterior intercostal line, where there are wider bony gaps and fewer nerves and blood vessels, further reducing postoperative pain. Conversely, multi-port surgery incisions are located in areas with dense nerve and blood vessel tissue, resulting in stronger pain sensations

and longer recovery periods. The short-term quality of life score at 2 months postoperatively was higher in the experimental group ($P < 0.05$). This is because single-port surgery has a less negative impact on the patient's immune system, reduces physiological stress responses caused by surgery, minimizes surgical trauma, and shortens postoperative recovery time [6]. The small incision length in single-port surgery limits tissue damage to a specific intercostal space, minimizing the impact on physiological functions and enhancing the patient's quality of life. Additionally, single-port surgery barely affects respiratory system function, allowing for early functional training and faster immune system recovery, thereby preventing various complications and improving the patient's quality of life [7,8].

However, it's important to note that both single and multi-port thoracoscopic techniques have their advantages and disadvantages. Single-port surgery offers high incision aesthetics, minimal damage to intercostal nerves, and prevention of chronic postoperative pain. Yet, it demands high technical proficiency in vascular management and lymph node dissection, resulting in a longer learning curve for operators. Moreover, its application in patients with thoracic deformities or obesity requires caution due to its limited indications. In contrast, multi-port surgery is more traumatic, prone to postoperative complications, and has a longer recovery period. However, it boasts simpler surgical operations and broader indications [9]. Therefore, in treating lung cancer patients, it's crucial to comprehensively evaluate their disease status, physical fitness, and treatment needs, taking their subjective preferences into account to select the most suitable thoracoscopic technique.

5. Conclusion

In summary, single and multi-port thoracoscopic techniques exhibit comparable overall treatment efficacy for lung cancer patients. However, single-port surgery offers advantages such as less intraoperative blood loss, reduced postoperative pain, and improved short-term quality of life. Its higher surgical feasibility makes it a preferred thoracoscopic technique for lobectomy.

Disclosure statement

The authors declare no conflict of interest.

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