Original Article

The short-term outcomes for the early removal of pigtail catheter drainage within 24 hours of uniportal video-assisted anatomic surgery in patients with lung cancer

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Background: Early removal of the chest tube has advantages of reducing postoperative pain and speed recovery. This study aimed to confirm its safety and feasibility of early removal of a pigtail catheter used as a chest drain in patients undergoing anatomical surgery.

Methods: This retrospective cohort study included 126 patients who removed pigtail catheter ≤24 h after surgery, and 56 patients >24 h who underwent uniportal video-assisted thoracic surgery (u-VATS) between January 2020 and April 2022. All patients had stage I lung cancer and underwent anatomical surgery (lobectomy or segmentectomy). The clinical characteristics, perioperative data, and postoperative complications of both groups were analyzed and compared.

Results: The >24 h group had more patients with a higher body mass index (BMI) (P<0.001), a lower forced expiratory volume in the first second (FEV1) (P<0.001), Chronic obstructive pulmonary disease (COPD) (P<0.001), and current smokers (P=0.006) than the ≤24 h group. There were no significant differences in terms of age, sex, type of resection, operation time, and bleeding loss between the two groups (P>0.05). The pain of patients in the ≤24 h group was significantly less than that in the >24 h group only on the third postoperative day (P=0.035). There were no significant differences in the postoperative visual analogue scale (VAS) at postoperative day 0, day 1, day 7, and 1 month between the two groups (P>0.05). With the exception of a higher occurrence of subcutaneous emphysema in the >24 h group (71.7% *vs.* 100%, P=0.001), there were no statistically significant differences in the postoperative complications (e.g., pneumonia, atrial fibrillation, atelectasis, pleural effusion, and wound infection) between the 2 groups (P>0.05). During the 30-day follow-up period, none of the patients required tube reinsertion for pneumothorax. A total of 8 patients in the ≤24 h group and 4 in the >24 h group required tube reinsertion (6.7% *vs.* 7.1%, P>0.99) due to pleural effusion.

Conclusions: In stage I lung cancer patients who underwent u-VATS anatomic surgery, the pigtail catheter used as a thoracic drainage tube removed with 24 h after was safe and feasible.

Keywords: Lung cancer; surgery; enhanced recovery after surgery (ERAS); drainage

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Introduction

Lung cancer was the 2nd most commonly diagnosed cancer and the leading cause of cancer death in 2020 (1). With the widespread use of computed tomography (CT), more and more lung cancer patients are being diagnosed at an early stage (2). Surgery is the main treatment for lung cancer (3,4). In the past few decades, enhanced recovery after surgery (ERAS) has been widely used in thoracic surgery and has improved patient outcomes, reduced postoperative morbidity, and enhanced patients' quality of life (5,6). As an important part of ERAS, the management of thoracic drainage tubes has always been a key issue for thoracic surgeons. The potential benefits of early tube removal include improving patients' ventilator function, reducing patients' discomfort and pain during deep breathing and reducing the incidence of respiratory complications (7).

Thoracic surgeons have explored the possibility of early chest tube removal or even no chest tube inserted, and studies have shown that it is feasible and safe to remove the chest tube early or even omit the use of the chest tube after a thoracoscopic wedge resection for carefully selected patients (8,9). However, the use of a chest tube is unavoidable when performing lobectomy or segmentectomy due to possible postoperative pleural effusion and pneumothorax. A previous study evaluated the safety and feasibility of removing the 24Fr chest drainage tube ≤24 h after lobectomy and segmentectomy (10). The pigtail catheter is already known to be less invasive than the regular chest tubes used to drain pleural effusion (11,12). We defined early chest tube removal as removal within 24 hours after surgery. Most thoracic surgeons consider it safe to drain less than 500 mL of fluid in the absence of air leaks, active bleeding, or chylothorax with well-inflated lungs. Early removal of chest tube after lung surgery not only makes patient mobility easier, but also leads to the fast-track recovery of the patients. Thus, this cohort study sought to the advantage of safety and feasibility of removing the pigtail catheter ≤24 h after video-assisted thoracic surgery (VATS) anatomic surgery in patients with lung cancer. We present the following article in accordance with the STROBE reporting checklist (available at https://tcr.amegroups.com/article/view/10.21037/tcr-22-1910/rc).

Methods

Study design and patients

This retrospective cohort study included consecutive patients with clinical stage I primary lung cancer who underwent anatomical pneumonectomy between January 2020 and April 2022 at the Department of Thoracic Surgery of The Third People's Hospital of Shenzhen. The patients were staged according to the 8th edition of the tumor, node, metastasis (TNM) staging system (13). The study was approved by the Ethics Committee of The Third People's Hospital of Shenzhen (Approval No. 2022-100-02). The requirement for informed consent was waived by the Ethics Committee due to the retrospective nature of the study. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

To be eligible for inclusion in this study, patients had to meet the following inclusion criteria: (I) have stage I lung cancer; (II) have undergone anatomical lung resection; (III) not have undergone any previous anti-tumor therapy for any malignant diseases; and (IV) have no surgical contraindications. Patients were excluded from the study if they met any of the following exclusion criteria: (I) had severe adhesions in the chest cavity; (II) had previously undergone ipsilateral thoracic surgery; (III) had undergone open surgery or were switched to thoracotomy during surgery; and/or (IV) had incomplete records. According to the guidelines (6), the patients were included in the improved ERAS program when the decision for surgery was made.

The safety of early removal of pigtail tubes is reflected in postoperative complications, and the feasibility is reflected in postoperative chest tube reintubation rates and rehospitalization rates.

Intraoperative management

The patients received an intercostal nerve block and an intrathoracic vagus nerve block (20 mL of 0.5% ropivacaine, 1 μg/Kg of dexmedetomidine, and 100 mL of 0.9% physiological saline). The bronchus, vein, and artery were separated anatomically and dissected with endostaplers (Covidien, Mansfield, MA, USA) or ligated before dissection. The water seal test was used intraoperatively to inspect for air leakage, and the intersegmental plane was closed by the continuous suturing of the pleural edge of the preserved segments; a 4-0 non-absorbable polypropylene monofilament was used if a severe air leak existed. After confirming that there was no obvious air leakage, surgical sealant was routinely used on the lung resection margin. Before closing the chest incision, a pigtail catheter was inserted next to the incision as a thoracic drainage tube. The incision was closed after the lungs were completely inflated

Table 1 Patient characteristics

Variables	≤24 hours[a] (n=120)	>24 hours[a] (n=56)	P
Age (years)	50.6±13.5	50.2±13.2	0.900
Sex (female)	68 (56.7%)	38 (67.9%)	0.321
Body mass index	25.5±1.9	27.9±1.7	<0.001
FEV1 (%predicted)	80.2±5.6	70.3±3.3	<0.001
Comorbidities	16 (13.3%)	24 (42.9%)	0.005
COPD	6 (5%)	20 (35.7%)	<0.001
T2DM	10 (8.3%)	4 (7.1%)	>0.99
Current smoker	26 (21.7%)	30 (53.6%)	0.006

[a], the continuous data are described as the means ± standard deviation and the categorical variables as the number (%). FEV1, forced expiratory volume in 1 second; COPD, chronic obstructive pulmonary disease; T2DM, type 2 diabetes mellitus.

under the surveillance of thoracoscopy. The chest tube was immediately connected to a digital drainage device (Thopaz, Medela AG, Switzerland) under –10 cmH_2O suction.

Data collection

Patients' clinical characteristics and perioperative data were obtained from the hospital electronic patient data system, including their age, sex, smoking status, body mass index (BMI), comorbidities, percentage of forced expiratory volume in 1 s (%FEV1), type of resection, operation time, intraoperative blood loss, time to remove chest drainage tube (≤24 or > 24 h), postoperative pain score, postoperative replacement chest tube rate and complications, postoperative complications, pneumonia, atrial fibrillation, pleural effusion, atelectasis, wound infection, subcutaneous, emphysema, reinsertion, and readmission. The follow-up period ran for 30 days after surgery.

The patients were also included in the ERAS program both before and after surgery. The indications for the removal of the chest tube were as follows: the exclusion of active bleeding, an air flow rate ≤20 mL/min without a spike for at least 4 h, and chest X-ray scans showing the complete recruitment of the remaining lungs regardless of the amount of drainage.

Chest X-rays and chest ultrasounds were routinely performed 1 day, 3 days, 1 week, and 1 month after surgery. After the patients were discharged from the hospital, the chest X-ray and chest ultrasound scans were performed at the outpatient clinic. On the 1st day after surgery, patients used a visual analog scale (VAS) to assess the intensity of their postoperative pain (on which 0–3 indicated mild pain, 4–6 indicated moderate pain, and 7–10 indicated severe pain). Celecoxib and acetaminophen were administered orally for analgesia to keep patients in a state of mild pain. All the patients were reassessed by their surgeon 2 days, 7 days, and 1 month after surgery at the outpatient clinic.

Statistical analysis

The data were analyzed using SPSS 24.0 (IBM, Armonk, NY, USA). The continuous data are described as the means ± standard deviation. The categorical variables are described as the number (%). The unpaired Student's *t*-test was used for the continuous variables with a normal distribution, and the Mann-Whitney U-test was used for the continuous variables with a skewed distribution. Pearson's chi-square test or Fisher's exact test was used for the categorical variables. Variables with P values <0.1 in the univariable analyses were selected as the independent variables for the multivariable logistic regression analysis. In this study, 2-tailed P values <0.05 were considered statistically significant.

Results

A total of 167 patients were included in the study. The pigtail catheter was removed ≤24 h after surgery in 120 patients (68%) and >24 h after surgery in 56patients (32%). In fact, 145 patients (82.4%) successfully had their drains removed within 3 days of surgery. The >24 h group had more patients with a higher BMI (P<0.001), a lower FEV1 (P<0.001), COPD (P<0.001), and who were current smokers (P=0.006) than the ≤24 h group (see *Table 1*). There were no significant differences in terms of age, sex, type of resection (lobectomy or segmentectomy) operation time, and bleeding loss between the 2 groups (all P>0.05) (see *Table 2*).

The patients in the >24 h group had a longer chest tube inserted time; however, it was only on the 3rd day after the operation (P=0.035) that the patients in the ≤24 h group had significantly less pain than those in the >24 h group; there were no significant differences in the postoperative VAS scores at postoperative day 0, day 1, day 7, and 1 month between the >24 h and the ≤24 h group (all P>0.05; see *Table 2*).

With the exception of a higher occurrence of subcutaneous emphysema in the >24 h group (P=0.001),

Table 2 Surgical and postoperative data

Variables	≤24 hours (n=120)	>24 hours (n=56)	P
Type of resection			
Segmentectomy	76 (63.3%)	32 (57.1%)	0.642
Lobectomy	44 (36.7%)	24 (42.9%)	0.642
Operation time (min)	166.5 (34.75)	185 (42.00)	0.089
Blood loss (mL)	32 (12.75)	36 (20.00)	0.070
VAS 0	2 (0.0)	2 (1.0)	0.730
VAS 1	2 (0.0)	2 (0.0)	0.452
VAS 3	1 (0.0)	1 (0.0)	0.035
VAS 7	1 (0.0)	1 (0.0)	0.093
VAS 30	0 (0.0)	0 (0.0)	>0.99
Postoperative complications			
Pneumonia	10 (8.3%)	6 (10.7%)	0.706
Atrial fibrillation	2 (1.7%)	0	>0.99
Pleural effusion	14 (11.7%)	4 (7.1%)	0.713
Atelectasis	2 (1.7%)	2 (3.6%)	0.538
Wound infection	4 (3.3%)	4 (7.1%)	0.589
Total	32 (26.7%)	16 (28.6%)	>0.99
Subcutaneous emphysema	86 (71.7%)	56 (100%)	0.001
Reinsertion	8 (6.7%)	4 (7.1%)	>0.99
Readmission	4 (3.3%)	2 (3.6%)	>0.99

VAS, Visual analogue scale, FEV1, forced expiratory volume in 1 second; COPD, chronic obstructive pulmonary disease; T2DM, type 2 diabetes mellitus.

there were no statistically significant differences in the postoperative complications (e.g., pneumonia, atrial fibrillation, atelectasis, pleural effusion, and wound infection) between the 2 groups (all P>0.05; see *Table 2*). During the 30-day follow-up period, none of the patients required tube reinsertion for pneumothorax. A total of 8 patients (6.7%) in the ≤24 h group and 4 (7.1%) in the >24 h group required tube reinsertion (P>0.99) due to pleural effusion. Among them, 4 patients (3.3%) in the ≤24 h group and 2 (3.6%) in the >24 h group were readmitted because of chylothorax (P>0.99), and the remaining patients with non-chylous pleural effusion were treated at outpatient clinics.

The univariable analyses showed that BMI (OR, 2.302; 95% CI: 1.654–3.389, P<0.001), FEV1 (OR, 0.633; 95% CI: 0.518–0.773, P<0.001), COPD (OR, 0.995; 95% CI: 0.23–0.382, P=0.010), comorbidities (OR, 5.633; 95% CI: 1.968–16.122, P=0.010), and being a current smoker (OR, 0.217; 95% CI: 0.82–0.575, P=0.020) were associated with chest tube removal ≤24 h after surgery (see *Table 3*). In the multivariable analysis, BMI (OR, 1.679; 95% CI: 1.040–2.709, P=0.034) and FEV1 (OR, 0.691; 95% CI: 0.563–0.848, P<0.001) were independently associated with tube removal ≤24 h after surgery (see *Table 3*).

Discussion

This study sought to determine the feasibility of removing a pigtail catheter, which has been used as a chest tube, ≤24 h after lobectomy and segmentectomy in patients with stage I lung cancer and the factors associated with early removal. This study showed that in patients with early stage lung cancer, who had undergone thoracoscopic anatomic pneumonectomy, the use of a pigtail catheter as a chest drain and its removal ≤24 h after surgery did not increase the incidence of complications and reduced patients' postoperative hospital stays. The results also suggest that BMI, FEV1, COPD, comorbidities, and being a current smoker were associated with chest tube removal ≤24 h after surgery. In the multivariable analysis, BMI (OR =1.679; 95% CI: 1.040–2.709, P=0.034), and FEV1 (OR =0.691; 95% CI: 0.563–0.848, P<0.001) were independently associated with chest tube removal ≤24 h after surgery. Specifically, a high FEV1 and a low BMI were risk factors for the removal of the pigtail catheter ≤24 h after lobectomy and segmentectomy in patients with stage I lung cancer in whom the ERAS protocol had been applied.

In this study, none of the patients were inserted due to pneumothorax. In the ≤24 h group, more patients needed double chest tube reinsertion compared to those in >24 h group; however, the difference was not statistically significant (P>0.99). Additionally, 4 patients (3.3%) in the ≤24 h group and 2 (3.6%) in the >24 h group were readmitted for chylothorax, but these rates were lower than those reported in a previous study (14), and the remaining patients with pleural effusion were drained at outpatient departments.

Pfeuty *et al.* (10) were the first to report that the drainage tube could be removed ≤24 h after thoracoscopic lobectomy or segmentectomy. In their study, 45% of the patients (G0) had the drainage tube removed ≤24 h after surgery with the help of the electronic drainage system, and the other patients (G1) had the drainage tube removed >24 h

Table 3 Univariable and multivariable regression models for potential factors associated with chest tube removal ≤24 h

Factors	Univariable		Multivariable	
	OR (95% CI)	P	OR (95% CI)	P
Age	0.998 (0.965, 1.032)	0.899	–	–
Sex	0.619 (0.241, 1.591)	0.320	–	–
BMI	2.302 (1.654, 3.389)	<0.001	1.679 (1.040, 2.709)	0.034
FEV1	0.633 (0.518, 0.773)	<0.001	0.691 (0.563, 0.848)	<0.001
Comorbidity	5.633 (1.968, 16.122)	0.010	6.396 (0.151, 271.583)	0.332
COPD	0.995 (0.230, 0.382)	0.010	0.140 (0.006, 3.246)	0.220
T2DM	0.846 (0.154, 4.654)	0.848	–	–
Current smoker	0.217 (0.820, 0.575)	0.020	0.990 (0.004, 2.646)	0.168
Segmentectomy	1.295 (0.519, 3.232)	0.579	–	–
Lobectomy	0.772 (0.309, 1.926)	0.579	–	–
Operation time	1.011 (0.996, 1.026)	0.138	1.005 (0.976, 1.035)	0.739
Bleeding loss	1.028 (0.992, 1.066)	0.128	0.942 (0.857, 1.035)	0.216

OR, odds ratio; CI, confidence interval; BMI, body mass index; FEV1, forced expiratory volume in 1 second; COPD, chronic obstructive pulmonary disease; T2DM, type 2 diabetes mellitus.

after surgery. Similar to the present study, with the help of electronic digital equipment, none of the patients required tube reinsertion for pneumothorax. However, 1 G0 patient (2.2%) was readmitted for delayed pleural effusion, and 1 G1 patient (1.8%) was readmitted for empyema. There were no significant differences between the 2 groups in terms of minor pneumothorax, subcutaneous emphysema, minor pleural effusion, cardiopulmonary complication, and 90-day readmission. It should be noted that in the present study, the 24Fr thoracic drainage tube was used. In a previous study based on data from The Surveillance, Epidemiology, and End Results (SEER) database, the 30-day readmission rate of 11,432 patients, aged 65 years of age or older, who had been admitted for pulmonary resection for lung cancer, was 12.8% (14), which was significantly higher than that in the present study. This study shows that with the help of an electronic drainage system, the pigtail catheter can also be used as a thoracic drainage tube after video-assisted thoracic lobectomy and segmentectomy without increasing postoperative complications and reintubation rates and can be removed ≤24 h after surgery.

Univariable and multivariable logistics regression models were used to identify the potential factors associated with the chest tube removal ≤24 h after surgery in patients with stage I lung cancer. Previous research has shown that non-current smokers, patients without COPD, and patients with a higher FEV1 were more likely to have their drain removed ≤24 h after surgery (10). In this study, the univariable analyses showed that BMI, FEV1, COPD, comorbidities, and being a current smoker were associated with chest tube removal ≤24 h after surgery. The multivariable analysis revealed that only BMI and FEV1 were independent risk factors.

With the promotion and application of ERAS in selected patients, removing the drainage tube ≤24 h after surgery increases the feasibility of performing thoracic surgery as a day surgery. Day surgery has not been widely used in thoracic surgery, including VATS. The currently reported and recognized types of thoracic day surgery are limited to bilateral thoracic sympathectomy, mediastinoscopy, bronchoscopy, and simple lung biopsy (15). The presence of urinary catheters limits the development of day surgery. A previous study showed that in the case of normal renal function, when the operation time is not long, it is not necessary to insert a urinary catheter (16). The presence of chest tubes for draining gas and liquid has become an obstacle to thoracic day surgery. Before closing the chest cavity during the operation, it needs to be confirmed that there is no air leakage in the lung. The application of biodegradable polymeric sealant and postoperative

continuous negative pressure suction can reduce air leakage and facilitate early chest tube removal (17,18). The absence of air leakages contribute to early extubation; however, the reduction of pleural effusion is equally important. Early postoperative eating can reduce pleural effusion by increasing enteral nutrition absorption and metabolism. The early removal of chest tubes makes day surgery possible.

This study had some limitations. First, it was a retrospective case-controlled study with a small study population. Second, all patients had early-stage lung cancer and were selected carefully. Because most patients underwent lymph node sampling, this may affect the timing of postoperative chest tube removal. Third, no data was provided as to whether the fissure was complete in the operation, and the type of thoracic drainage tube that was inserted depended on the surgeon's choice. Thus, a prospective large-scale multicenter randomized control study needs to be conducted to confirm these results.

Conclusions

This study showed that the use of the pigtail catheter as a thoracic drainage tube after video-assisted thoracic lobectomy and segmentectomy is safe and feasible for stage I lung cancer patients, and chest tubes are more likely to be removed ≤24 h after surgery in patients with a low BMI and a high FEV1.

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Footnote

Reporting Checklist: The authors have completed the STORBE reporting checklist. Available at https://tcr.amegroups.com/article/view/10.21037/tcr-22-1910/rc

Data Sharing Statement: Available at https://tcr.amegroups.com/article/view/10.21037/tcr-22-1910/dss

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Ethical Statement: 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 study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Ethics Committee of The Third People's Hospital of Shenzhen (Approval No. 2022-100-02). The requirement for informed consent was waived by the Ethics Committee due to the retrospective nature of the study.

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