ORIGINAL ARTICLE

A RETROSPECTIVE ANALYSIS ON LEVEL OF SUCTION IN DIGITAL DRAINAGE DEVICES AFTER VIDEO-ASSISTED LOBECTOMY IN A THORACIC SURGERY CENTRE

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Abstract

Introduction: *The management of chest tubes after pulmonary resection remains non-standardized, and suction levels are often determined by the surgeon's preference. This retrospective study aimed to compare the clinical outcomes of low suction (-2cmH_2O) versus the conventional suction level used in our institution (-15cmH_2O) using digital drainage devices after video-assisted thoracic surgery (VATS) lobectomy for suspected or confirmed lung cancer in a thoracic surgery centre.*

Methods: *We analysed 120 patients who underwent pleural drainage after VATS lobectomy between January 2023 and September 2024. The primary outcome was drainage duration. Secondary outcomes included hospital stay, prolonged air leak, complications, and readmissions.*

Results: *No significant differences were observed in drainage duration (2.0 vs. 4.0 days; p=0.125) or hospital stay (3.0 vs. 4.0 days; p=0.104). The incidence of prolonged air leak was similar between groups (20.3% vs. 24.6%; p=0.578). However, subcutaneous emphysema occurred more frequently in the low suction group (22% vs. 8.2%; p=0.04), with a higher need for intervention, despite comparable baseline forced expiratory volume in the first second (FEV1) values between suction level groups. Importantly, patients who developed subcutaneous emphysema had significantly lower baseline FEV1 values, regardless of suction level. COPD was identified as a significant predictor of longer drainage duration, longer hospital stay, and higher complication rates.*

Conclusion: *Although suction level did not significantly influence postoperative recovery, the higher incidence of subcutaneous emphysema in the low suction group warrants further investigation. The presence of COPD and impaired baseline lung function should be considered when selecting suction levels after VATS lobectomy.*

Keywords*: Pleural drainage, Suction level, Chest tubes, VATS lobectomy, Prolonged air leak*

INTRODUCTION

There are no established guidelines regarding the management of chest tubes after pulmonary resection. The decision to apply suction or to maintain the chest tube on water seal remains largely at the surgeon's discretion. Although current evidence shows no improvement in drainage duration or air leak incidence with the use of suction, negative pressures between -10cmH_2O and -20 cmH_2O are still routinely applied[1]. Holbek et al.[2] conducted a randomized controlled trial demonstrating a reduction in drainage duration, hospital stay, and time to air leak cessation when low suction of -2cmH_2O was applied in digital drainage devices after video-assisted thoracic surgery (VATS) lobectomy, compared with -10cmH_2O suction, without an increase in morbidity. Some series have reported a lower incidence of prolonged air leak (PAL) following VATS lobectomy compared with thoracotomy[3]. This minimally invasive approach may reduce parenchymal injury, potentially decreasing the need for high levels of postoperative suction. In this context, the rationale for applying lower suction levels after VATS lobectomy has gained increasing interest.

The aim of this retrospective study was to compare clinical outcomes between low suction (-2cmH_2O) and the

Table 1 **Summary of smoking status, comorbidities and previous medical history in the study cohort. Values are presented as n (%).**

	-2cmH2O (n=59)	-15cmH2O (n=61)
Smoking status		
- Non smoker	24 (40.1)	25 (41.0)
- Former smoker	27 (45.8)	20 (32.8)
- Active smoker	8 (13.6)	15 (24.6)
COPD	9 (15.3)	8 (13.1)
Asthma	3 (5.1)	1 (1.6)
Cardiovascular disease	41 (69.5)	47 (77.0)
Ipsilateral lung surgery	0 (0)	0 (0)
Previous lung cancer	0 (0)	0 (0)
Previous thoracic radiation	3 (5.1)	1 (1.6)

Table 2 **Summary of complications in the study cohort. Values are presented as n (%).**

	-2cmH2O (n=59)	-15cmH2O (n=61)
Wound infection	1 (1.7)	2 (3.3)
Atrial fibrillation	1 (1.7)	1 (1.6)
Bilateral pulmonary thromboembolism	1 (1.7)	0 (0.0)
Nosocomial pneumonia		
Without mechanical ventilation	1 (1.7)	5 (8.0)
With mechanical ventilation	1 (1.7)	0 (0.0)
Heart failure	1 (1.7)	0 (0.0)
Reoperation		
Due to bleeding	1 (1.7)	0 (0.0)
Due to air leak	1 (1.7)	0 (0.0)
Any complication (total)	8 (13.6)	8 (13.1)

conventional suction level used in our institution (-15cmH_2O) in patients managed with digital drainage devices after VATS lobectomy for suspected or confirmed lung cancer in a thoracic surgery centre.

METHODS

We conducted a retrospective analysis of patients who underwent pleural drainage with a Thopaz® digital drainage device after VATS lobectomy for suspected or confirmed lung cancer between January 2023 and September 2024 at a thoracic surgery centre. Two suction levels were compared: low suction (-2cmH_2O) and conventional suction (-15cmH_2O). The conventional suction level of -15 cmH_2O reflected standard clinical practice in our institution during the study period, despite the absence of a formal institutional protocol. Low suction of -2 cmH_2O was adopted following the publication of evidence suggesting potential clinical benefits of this suction level. Its use, however, was not protocolized, and patient allocation was not randomized. The initial suction level was determined according to the assistant surgeon's preference and routine clinical practice. During the postoperative period, suction adjustments were also made at the discretion of the assistant surgeon based on clinical judgment, leading to crossover of suction levels in a subset of patients. All analyses were performed according to the intention-to-treat principle, with patients analyzed based on the initial suction level assigned, regardless of subsequent changes in suction during the postoperative period.

Data on patient demographics, comorbidities, lung function [forced expiratory volume in the first second (FEV1) and diffusing capacity of the lungs for carbon monoxide (DLCO)], duration of thoracic drainage, length of hospital stay, complications, and readmissions were collected from medical records. The primary outcome was drainage duration, measured in days. Secondary outcomes included hospital stay, incidence of PAL (defined as air leak persisting beyond the fifth postoperative day), complications, occurrence of subcutaneous emphysema, and readmission rates.

Statistical analysis were performed using IBM SPSS Statistics ver.28. Descriptive statistics were expressed as measures of central tendency. Logistic regression models were applied to evaluate the impact of suction level on the occurrence of subcutaneous emphysema and other complications. Odds ratios (OR) with 95% confidence intervals (95% CI) were calculated, adjusting for confounders when appropriate. Statistical significance was defined as $p < 0.05$.

RESULTS

A total of 246 patients underwent pleural drainage after VATS lobectomy for suspected or confirmed lung cancer between January 2023 and September 2024 at a thoracic surgery centre. Of these, 126 patients were excluded from the cohort because the suction level differed from the study parameters, a Thopaz® digital drainage device was not used, or clinical records regarding the level of suction were unavailable.

We evaluated 120 patients, of whom 59 underwent low suction (-2cmH_2O) and 61 underwent conventional suction (-15cmH_2O). The median age in the overall cohort was 68 years [Interquartile range (IQR) 61-73]. Smoking status, comorbidities, history of lung cancer, ipsilateral lung surgery, or thoracic radiation are summarized in Table 1. The median FEV1 was 93% predicted [IQR 82-106] in the -2cmH_2O group and 97% predicted [IQR 82-108.5] in the -15cmH_2O group. The median DLCO was 87% predicted [IQR 74-100] and 76% predicted [IQR 66.5-91]

Table 3 **Summary of primary and secondary outcomes in the study cohort. Drainage duration and hospital stay are expressed in days [IQR]. Prolonged air leak, subcutaneous emphysema (with or without intervention), complications, and readmissions are presented as n (%). Corresponding p values are shown.**

	-2cmH2O (n=59)	-15cmH2O (n=61)	p value
Drainage duration	2.0 [IQR 2.0-5.0]	4.0 [IQR 2.0-6.0]	0.125
Hospital stay	3.0 [IQR 2.0-5.0]	4.0 [IQR 2.0-7.0]	0.104
Prolonged air leak	12 (20.3)	15 (24.6)	0.578
Subcutaneous emphysema (adjusted to lung function)	13 (22)	5 (8.2)	0.04
Subcutaneous emphysema requiring intervention adjusted to lung function)	13 (22)	4 (6.6)	0.025
Complications	8 (13.6)	8 (13.1)	0.111
Readmission	5 (8.5)	1 (1.6)	0.943

Table 4 **Incidence of each lobectomy by group. Values are presented as n (%).**

	-2cmH2O (n=59)	-15cmH2O (n=61)
URL	20 (33.9)	18 (29.5)
LRL	17 (28.8)	11 (18.0)
ML	3 (5.1)	4 (6.6)
ULL	7 (11.9)	9 (14.8)
LLL	12 (20.3)	19 (31.1)

URL: upper right lobectomy, LRL: lower right lobectomy,
ML: middle lobectomy, ULL: upper left lobectomy, LLL: lower left lobectomy.

for the -2cmH_2O and -15cmH_2O groups, respectively.

For the -2cm$H_2$0 and -15cmH_2O groups, the median duration of drainage was 2.0 days [IQR 2.0-5.0] and 4 days [IQR 2.0-6.0], respectively (p=0.125). The median length of hospital stay was 3.0 days [IQR 2.0-5.0] and 4.0 days [IQR 2.0-7.0] for the -2cmH_2O and -15cmH_2O groups, respectively (p=0.104).

The incidence of PAL was 20.3% (12 patients) in the -2cmH_2O group and 24.6% (15 patients) in the -15cmH_2O group (p=0.578).

In the -2cmH_2O group, 13 patients (22%) developed subcutaneous emphysema, all of whom required intervention: 11 (18.6% of the group) required an increase in suction level, and 2 required insertion of an additional chest tube. Suction adjustments were performed at the discretion of the assistant surgeon, without a predefined protocol. 8 patients (13.6%) experienced complications, and 5 patients (8.5%) were readmitted to the hospital. Readmissions were due to subcutaneous emphysema and pneumothorax in 3 patients (2 requiring chest tube insertion and 1 managed conservatively), pleural effusion in 1 patient, and urinary tract infection requiring intravenous antibiotic therapy in 1 patient. Complications are summarized in Table 2.

In the -15cmH_2O group, 5 patients (8.2%) developed subcutaneous emphysema, 4 of whom (6.6%) required intervention: 3 required an additional chest tube and 1 underwent chest tube mobilization. 8 patients (13.1%) experienced complications, and 1 patient (1.6%) was readmitted to the hospital due to subcutaneous emphysema and pneumothorax, which was managed conservatively. Complications are summarized in Table 2. No significant differences were observed in the rates of complications (p=0.111) or readmissions (p=0.943) between the two groups. Primary and secondary outcomes are summarized in Table 3.

When adjusted for lung function, the conventional suction (-15cmH_2O) group showed significantly lower odds of developing subcutaneous emphysema [OR 0.296; 95% CI 0.093-0.944, p=0.04] and of developing subcutaneous emphysema requiring intervention [OR 0.241, 95% CI 0.07-0.83, p=0.025]. Patients who developed subcutaneous emphysema had significantly lower baseline FEV1 values compared with those without subcutaneous emphysema (median 84.5% [IQR 73.3–103.0] vs 97.0% [84.8–108.0]; p=0.025). In contrast, baseline FEV1 (% predicted) was similar between suction level groups (-2 cmH_2O: median 93.0% [IQR 82.0–106.0] vs -15 cmH_2O: 97.0% [82.0–108.5]; p=0.603).

When adjusted for suction level, patients with chronic obstructive pulmonary disease (COPD) had a longer drainage duration (p=0.042), a longer hospital stay (p=0.032), and a higher likelihood of complications [OR 6.41, 95% CI 1.44-28.75; p=0.013], compared with those without COPD.

Men had a significantly longer drainage duration (4 days [IQR 2-9] vs 2 days [IQR 2-3], $p<0.001$) and a longer hospital stay (4 days [IQR 2-9] vs 2 days [IQR 2-4], $p<0.001$). The affected lobe was not significantly associated with a longer hospital stay ($p=0.316$). The distribution of lobectomies is summarized in Table 4.

DISCUSSION

The duration of drainage is one of the main determinants of hospital length of stay after thoracic surgery. However, chest tube management is not standardized and is largely determined by individual preference and experience.

Several studies in the literature have debated the use of suction after pulmonary resection. Some have compared conventional drainage systems under suction versus water seal, both in open and thoracoscopic surgery[4], while others focused exclusively on open surgery[5]. Overall, these studies found that the application of suction provides no benefit in promoting air leak cessation. In fact, some reports have demonstrated a greater advantage of using no suction after pulmonary resection[6-8]. Moreover, two additional studies showed no superiority of suction when using digital drainage devices after lobectomy by thoracotomy[9,10].

However, most of these studies have compared the use of suction after pulmonary resection performed by open surgery or with conventional drainage systems. The study by Holbek et al.[2] addressed an important gap in the existing evidence, as it was the first to compare suction versus no suction using digital drainage devices after VATS lobectomy.

This retrospective analysis aimed to compare the clinical outcomes between two groups - low suction (-2cmH_2O) versus conventional suction (-15cmH_20) - using digital drainage devices after VATS lobectomy for suspected or confirmed lung cancer at a single thoracic surgery centre. Compared with low suction, conventional suction of -15cmH_2O showed no significant differences in pleural drainage duration, hospital length of stay, rate of PAL, complications, or readmissions. Although a trend toward shorter drainage duration and hospital stay was observed with low suction, statistical significance was not achieved. Therefore, these results should be interpreted with caution, particularly given the limited sample size. Also, patients who developed subcutaneous emphysema had poorer baseline FEV1, suggesting that poorer pulmonary function may identify a subgroup of patients with increased vulnerability to the development of subcutaneous emphysema.

These findings are consistent with previous reports suggesting that the application of suction does not have a substantial clinical impact. However, a significant difference was observed in the rate of subcutaneous emphysema, which was higher in the low suction group, despite comparable baseline FEV1 values between suction level groups. The occurrence of subcutaneous emphysema required active intervention in a considerable number of patients in the -2cmH_2O group, raising questions about the pleural drainage dynamics in this setting. This finding suggests that careful monitoring and individualized management of suction levels may be warranted in patients with significant air leak to minimize further complications, such as the need for additional chest tube placement.

When adjusted for suction level, patients with COPD had longer drainage duration and hospital stay, as well as a higher likelihood of complications. Within each group, the presence of COPD was the main predictor of drainage duration. These findings reinforce the importance of individualized postoperative management and tailoring suction levels according to patients' underlying pulmonary function and comorbidities.

Despite these findings, this study has several limitations. The analysis was retrospective, conducted in a single centre and patient allocation was not randomized, with the known limitations of this design. Moreover, during the drainage period, suction levels were modified in some patients, leading to crossover. In cases where suction was adjusted, the decision was made by the assistant surgeon rather than being based on a prespecified protocol. Suction changes occurred in two specific groups of patients: in the -2cmH_2O group, suction was increased due to the development of subcutaneous emphysema, whereas in the -15cmH_2O group, suction was decreased to -8cmH_2O on the first postoperative day if no air leak was observed and the chest radiograph showed no signs of complications. Although this limitation is unlikely to have significantly affected the results, the possibility of bias cannot be completely excluded.

CONCLUSION

The results of this analysis suggest that the level of suction after VATS lobectomy may not be a determining factor in postoperative recovery. Nevertheless, the higher incidence of subcutaneous emphysema observed in the -2cmH_2O group is a relevant finding that warrants further investigation and reinforces the need for individualized postoperative management. In particular, patients with COPD and poorer baseline FEV1 may require closer monitoring and a lower threshold for intervention to prevent further complications.

Overall, suction level should be individualized according to each patient's lung function, comorbidities, and risk of related adverse events.

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