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Pleural-cutaneous fistula after uniportal non-intubated thoracoscopic lung volume reduction surgery: does the route of the chest tube matter? A two cases report

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Abstract

Background Interventional management of chronic obstructive pulmonary disease of the emphysema phenotype, include uniportal, non-intubated, video-assisted thoracic surgery (UNI-VATS) lung volume reduction surgery (LVRS), which has shown to offer significant clinical benefit and minimized surgery- and anesthesia-related morbidity. Nevertheless, the insertion of the chest tube through the single surgical incision may constitute a trigger-point for wound-related complications. Herein we report on two patients with severe emphysema who developed wound infection and pleural-cutaneous fistula following UNI-VATS LVRS.

Cases presentation : In both patients the chest tube had been placed through the single surgical incision and the post-operative course was complicated by prolonged air leaks requiring discharge with the tube connected to a Heimlich valve. Following eventual removal of the chest tube, both patients came back to the emergency department on post-operative day 23 and 26, respectively, due to signs of local infection and pain. In one instance a recurrent pneumothorax required surgical debridement and placement of a further chest tube whereas in the other, sole surgical debridement at the surgical site proved curative. In both instances chest computed tomography clearly documented the pleural-cutaneous fistula first, and full recovery with complete lung re-expansion and proper wound healing subsequently.

Conclusions These cases, which had never been reported so far, highlight a potentially preventable complication of UNI-VATS LVRS and suggest that alternative drainage strategies should be considered in patients at high-risk of prolonged air leaks.

Keywords Video-assisted thoracic surgery, Lung volume reduction surgery, Chest tubes, Wound infection, Non-intubated VATS, Pleural-cutaneous fistula, Case reports

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Background

Uniportal, non-intubated, video-assisted thoracic surgery (UNI-VATS), represents in our experience a safe and reliable operative strategy that is applied to a number of surgical indications including lung volume reduction surgery (LVRS) [1]. Theoretical advantages of this strategy derive from the combination of a minimally invasive surgical access, resulting in reduced surgical trauma and post-operative pain [2], and the maintenance of spontaneous ventilation, which eliminates the risks of mechanical airways injury and ventilator-induced lung injury, preserves diaphragmatic motion and may improve hemodynamic stability [3]. Overall, these benefits have shown to translate into reduced morbidity and shorter hospital stay, which has proven particularly relevant in frail patients with severe emphysema [1, 4]. Despite the potential strengths associated with this strategy, we also experienced some issues related to chest tube positioning at the end of surgery. Indeed, as well as in most of UNI-VATS procedures, the chest drainage is commonly placed through the single utility port. Unfortunately, this choice can be associated with wound complications, particularly whenever the tube is maintained for more than 5–7 days due to long-lasting air leaks. Herein we report about 2 patients who developed wound infection and pleural-cutaneous fistula following UNI-VATS LVRS and we discuss about alternative options aimed at avoiding the risk.

Case presentation

Patient #1

A 64-year-old male with severe upper-lobe predominant emphysema, with forced expiratory volume during the first second of 29% predicted and a residual volume of 230% predicted, underwent right-sided UNI-VATS LVRS within a staged bilateral treatment program. He was a former smoker with a 35 pack-years history and had no other significant comorbidities besides emphysema. The patient received cefazolin 2 g as peri-operative prophylaxis about 30 min before surgery. During surgery, no sealants or other materials were adopted to reinforce staple line. At the end of surgery, a 28 Fr silicone chest tube was placed through the utility incision. Suction at -20 cmH_2O was applied until post-operative day 1 and was then discontinued in the absence of subcutaneous emphysema. Following surgery, the post-operative course was complicated by prolonged air leaks and the patient was discharged on post-operative day 5 with a Heimlich valve with indication not to remove the dressing around the thoracostomy site and to undergo outpatient follow-up every 3 days. The chest tube was eventually removed in outpatient setting on post-operative day 12 with no signs of wound infection. On post-operative day 23, the patient presented at the emergency department with chest pain. Blood tests showed leukocytosis (white blood cell count 16,000/μL), elevated C-reactive protein (250 mg/L), and increased procalcitonin levels (3 ng/mL). Chest computed tomography (CT) revealed a wound infection and a pleural-cutaneous fistula with small loculated pneumothorax (Fig. 1). No bacterial growth was detected on wound swab culture. The patient underwent surgical debridement during which communication between the pleural cavity and skin incision was clearly evident, and re-suturing of the wound without the need for further chest drainage. Inflammatory markers progressively improved with targeted antibiotic therapy (ceftriaxone 2 g daily for 7 days), and he was discharged uneventfully four days later with instructions to continue antibiotic therapy at home.

Patient #2

A 69-year-old male with upper-lobe predominant emphysema, a forced expiratory volume during the first second of 34% predicted and a residual volume of 200% predicted, underwent left-sided UNI-VATS LVRS within a program of staged bilateral treatment. He also had a history of hypertension and benign prostatic hyperplasia and was a former smoker of about 60 pack-years. The patient received cefazolin 2 g as peri-operative prophylaxis approximately 30 min before surgery. During LVRS, no sealants or other materials were used to reinforce staple line. At the end of surgery, a 28 Fr silicone chest tube was placed through the utility incision. Suction at -20 cmH_2O was applied until post-operative day 1 and was then discontinued in the absence of subcutaneous emphysema. Moderate air leaks were still persisting on post-operative day 6 and the patient was thus discharged with a Heimlich valve with indication not to remove the dressing around the thoracostomy site and to undergo outpatient follow-up every 3 days. The chest tube was removed in outpatient setting on post-operative day 18. No signs of wound infection were present at the time of tube removal. Eight days later, he presented at the emergency department with dyspnea and chest pain. Blood tests showed leukocytosis (white blood cell count 17,000/μL), elevated C-reactive protein (130 mg/L), and increased procalcitonin levels (2 ng/mL). High-resolution CT revealed a pleural-cutaneous fistula with pneumothorax and subcutaneous emphysema (Fig. 1). Pseudomonas aeruginosa was found at wound swab culture. During surgical debridement performed in the operating room, communication of the pleural cavity with the skin incision was detected and new chest tube was also inserted. Subsequently, the patient underwent targeted antibiotic therapy (piperacillin/tazobactam 4.5 g every 6 h for 10 days) with eventual improvement of inflammatory markers. He was discharged uneventfully 12 days later.

In both patients, at the 3-month follow-up, wound healing was satisfactory, and chest high-resolution CT

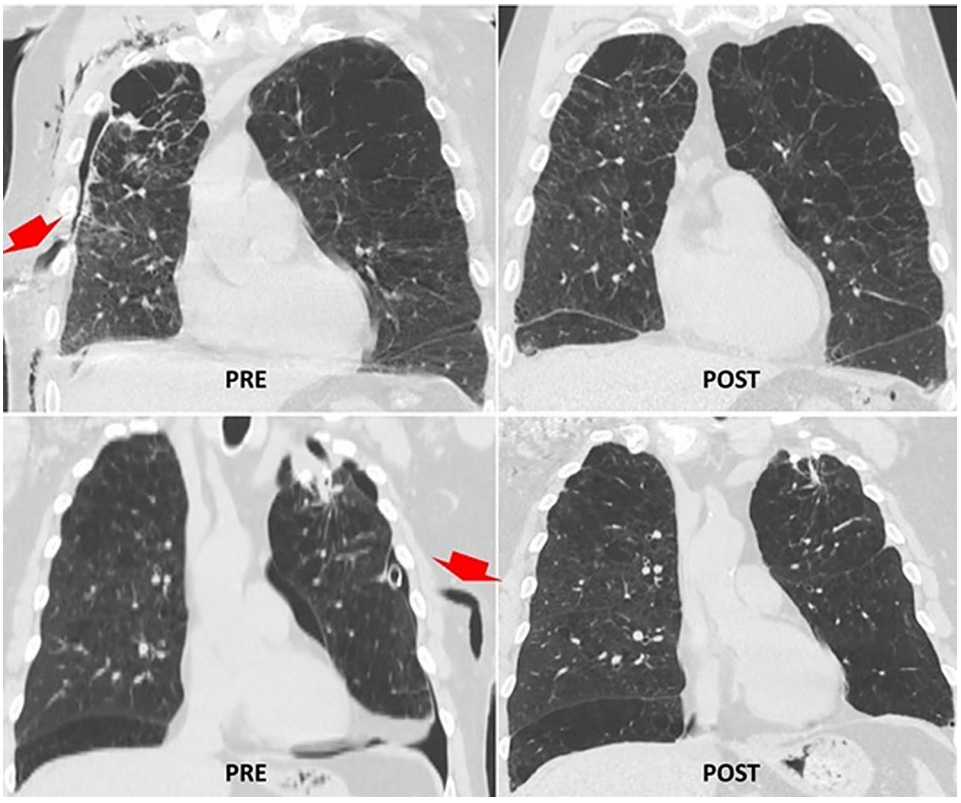

Fig. 1 Pre-operative (left) and post-operative (right) computed tomography coronal images in patient #1 (upper) and #2 (bottom) depicting the pleural-cutaneous fistula (right arrows) and the full recovery at 3 months in both patients following surgical debridement plus novel chest tube placement (patient 2 only)

imaging showed complete lung re-expansion and full resolution of the pleural-cutaneous fistula (Fig. 1). Patients' clinical characteristics and outcomes are summarized in Table 1.

Conclusions

This is the first report dealing with post-operative wound infections with pleural cutaneous fistulas following UNI-VATS LVRS. In this setting we believe that the combination of prolonged air leaks and chest tube placement through the surgical port skin incision, represented the most important risk-factor leading to wound infection and subsequent development of further complications such as pneumothorax with deteriorating dyspnea. In addition, our cases suggest that even when chest tube removal occurs within commonly accepted timeframes, wound-related complications may still arise due to the tube itself, which is likely to eventually lead to a mechanical-inflammatory foreign-body reaction.

Prolonged air leaks, typically defined as an air leak lasting more than 5 days, remains one of the most frequent complications following LVRS. Its incidence ranged between 24% and 46% in this population [5] which constitutes higher rates than that reported following lobectomy, which account for approximately 26% [6]. The higher risk seems attributable to the pathological features of emphysematous lung tissue, including decreased elasticity, friable parenchyma, and extensive bullous changes, which undermine the staple line integrity and impair sealing. Despite continuous advancements in surgical tools (e.g. reinforced staplers), reinforcement materials, and closure strategies, together with the adoption of non-intubated strategies, with avoidance of barotrauma due to mechanical ventilation and the possibility of early mobilization after surgery, no reintervention has yet demonstrated consistent efficacy in preventing or avoiding this complication [7]. Although air leaks can rarely become dangerous in terms of mortality risks, it may facilitate the development of subcutaneous emphysema, prolonged chest tube duration, delayed mobilization, increased risk of pleural infection, greater chest pain and long hospitalization times. Furthermore, persistent drainage through the surgical incision may contribute to wound-related issues, such as contamination, infection and dehiscence. These factors underscore the importance of optimizing air leak management and the choice of an optimal route for chest tube placement, especially following UNI-VATS LVRS.

The correlation between prolonged air leaks and post-operative infectious complications has been already

Table 1 Visual summary of the patients' clinical characteristics and outcomes

Variable	Patient 1	Patient 2
Age	64 years	69 years
Emphysema pattern	Upper-lobe predominant	Upper-lobe predominant
FEV1, mL (% predicted)	660 (29)	744 (34)
RV, L (% predicted)	6.2 (230)	5.9 (200)
Surgical approach	UNI-VATS LVRS	UNI-VATS LVRS
Air leak duration (days)	11	17
Chest tube removal (days)	12	18
In hospital re-admittance	11 days after tube removal	8 days after tube removal
Complication	Wound infection Loculated pneumothorax Pleural-cutaneous fistula	Wound infection Pneumothorax Pleural cutaneous fistula
Treatment	Surgical debridement + targeted antibiotic therapy	Redo-chest drainage + targeted antibiotic therapy
Discharge (post-complication)	4 days after debridement	12 days after re-drainage
3-month follow-up	Full lung expansion, healed wound	Full lung expansion, healed wound

FEV1: forced expiratory volume during the first second; LVRS: lung volume reduction surgery; RV: residual volume; UNI-VATS: uniportal non-intubated video-assisted thoracic surgery

shown in literature. In a retrospective cohort study of 110 patients who underwent VATS pulmonary resection, those who developed prolonged air leaks had significantly higher rates of wound infection and empyema compared to those without this complication ($P = 0.005$ and $P = 0.023$, respectively) [8].

To mitigate such risks, several technical refinements have been proposed to minimize contamination of the primary surgical site. Xu et al. described a simple continuous suture technique to reinforce the intramuscular closure during chest tube removal in uniportal VATS [9]. Furthermore, lateral positioning of a small-caliber pigtail catheters (12–15 Fr), placed near but not through the main surgical incision, has been proposed as a safe and effective strategy in patients undergoing uniportal VATS [10]. In our experience, small drainage systems proved insufficient in patients with emphysema undergoing LVRS in whom a high-flow air leak may develop postoperatively. In fact, we noticed that in these instances, an excessively small (15Fr) catheter may prove insufficient to drain all air, resulting in incomplete lung re-expansion and eventually facilitating the development of subcutaneous emphysema. For this reason, based on our clinical practice, we do not adopt anymore small catheters after LVRS.

Palleschi et al. introduced submuscular tunneling for drain insertion [11]. By this technique, the chest tube is passed through a skin incision located inferior to the primary wound and then advanced within the submuscular plane before entering the pleural cavity through a unique intercostal opening. By this strategy the preservation of the main surgical wound's structural integrity is assured by avoiding direct contact between the drainage tube and the incision site [11]. Since the occurrence of the currently reported complications, we also have adopted this method in UNI-VATS LVRS with excellent results and no further case of wound infection amongst 36 patients who developed prolonged air leaks out of 210 patients undergoing UNI-VATS LVRS.

Taken together, the two cases presented in this report illustrate a clinically relevant and under-recognized complication related to UNI-VATS LVRS. Both patients developed pleural-cutaneous fistulas associated with wound infections, despite technically successful surgeries, which however were complicated by prolonged air leaks. In both instances, the chest tube was placed through the surgical incision, and the duration of drainage fell within the range generally considered safe. Worthy of note, in one of our patients the pleuro-cutaneous fistula resulted in a small loculated pneumothorax, which did not require further drainage placement. This was probably due to the development of pleural adhesions, which fixed the lung to the chest wall.

Our cases may contribute to highlight the importance of the chest tube route within UNI-VATS LVRS because of the risks for serious post-operative morbidity, especially in the setting of prolonged air leaks. Pathophysiology of the increased risk of wound infection and pleural-cutaneous development remain speculative. It is possible that prolonged maintenance of the chest tube may either facilitate contamination of the wound from previous infection of the pleural cavity through the bronchopleural fistula sustaining the air leak or rather, it may be facilitated by contamination of the external side of the tube, which subsequently extend to the wound through the skin passage of the tube.

In conclusion, we have reported about 2 patients undergoing UNI-VATS LVRS complicated by prolonged air leaks who developed wound infection and pleural-cutaneous fistula that needed in-hospital readmission and surgical debridment eventually resulting in complete resolution. Since in both patients the chest tube was passed through the uniportal skin incision, we suggest that alternative chest drain routes should be preferred in order to minimize risks of such a potentially life-threatening complication particularly in fragile cohorts.

Abbreviations

CT	Computed tomography
LVRS	Lung volume reduction surgery
UNI-VATS	Uniportal, non-intubated video-assisted thoracic surgery

Supplementary Information

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Supplementary Material 1

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All data generated or analyzed during this study are included in this published article.

Declarations

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Ethical approval was not required for this study. Consent to participate was not applicable.

Consent for publication
Both patients gave consent for publication.

Competing interests
The authors declare that they have no competing interests.

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