Editorial on Prolonged Air Leak after Lung Surgery: Prediction, Prevention and Management

Prolonged air leak after lung surgery: prediction, prevention and management

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Prolonged air leak (PAL) after lung anatomical resection remains a long-unsolved problem. After the advent of minimally invasive thoracic surgery (MITS) and the enhanced recovery after surgery (ERAS) era, PAL significantly burdens the postoperative course (1). Often the average hospital stay is less than 5 days, so the appearance of PAL can prolong it. Even in the presence of PAL, patients are increasingly discharged home early with a thoracic drainage system (2,3). Some studies have shown in these patients an increase in hospital readmissions and costs (4,5). PAL after video-assisted thoracic surgery (VATS) anatomical resections has a high clinical and economic impact and should be avoided. Prevention plays a fundamental role.

There are three stages in which we can act:

(I) In the preoperative phase, with the adoption of predictive risk models;
(II) Intraoperatively through the stratification of patients at risk of PAL and the selective treatment of intraoperative alveolar air leaks (IAALs);
(III) In the postoperative period, with proper management of the chest tube.

As we have demonstrated, current risk models do not have sufficient discriminatory capacity to be used in standard clinical practice (6). The C statistics of the best four PAL risk models (7-10) do not exceed 0.65. Like the weather, reliably predicting good and bad conditions can change human behaviour (11). This could drive surgeons to quickly remove chest tubes in low-risk cases and use expensive prophylactic therapies for high-risk cases. Nevertheless, currently, predictive models are not yet particularly discriminatory. One possible reason is that there is a high level of randomness in the occurrence of PAL, which probably cannot be reduced. The other possibility is that until now, the models did not include some essential variables. In our view, the addition of objective intraoperative assessment of IAAL to the well-known preoperative and postoperative risk factors is key to improving the success of PAL prediction and prevention.

Many surgeons suggest detecting IAALs through an immersion test after completing a VATS anatomical resection (12) or through new methods (13). The next step represents the crux of the prevention of PAL. If the immersion test is positive, in our opinion, to follow a logical progression, an objective quantification of air leaks through a mechanical ventilation test (MVT) is mandatory because it allows classifying IAALs (14) into:

- Mild (<100 mL/min).
- Moderate (>100 and <400 mL/min).
- Severe (>400 mL/min).

Some evidence supports this classification. Takamochi *et al.* demonstrated that a postoperative loss <100 mL/min is usually self-limiting (15). An air loss >100 mL/min during the first 24 hours after surgery is significantly helpful in predicting PAL after lung resection. We have previously shown that in unselected patients with moderate IAAL (>100 and <400 mL/min) and not treated intraoperatively (control group), the duration of postoperative air leak is 5.04±3.63 days (16). Brunelli and colleagues demonstrated

that unselected patients submitted to lobectomy with an IAAL >500 mL/min measured after lung resection would have an expected air leak duration of 15 days (17). Whether there is a consensus on considering mild IAAL as self-limiting and not to be treated, moderate IAAL is still a matter of debate. We have shown that intraoperative sealing treatment of unselected patients with moderate IAAL significantly reduces hospitalization length (2.1 days) and hospitalization costs (16). However, this is only true in centres where patients are not discharged early with chest drainage. Therefore, these patients must be stratified by other known risk factors. This way, we will be able to predict PAL more accurately. Takamochi (15) has already been able to demonstrate a significant correlation between patients at high risk for PAL and a moderate postoperative AL (air leak >100 mL/min) to predict PAL.

Further studies are needed to demonstrate a close correlation between PAL and IAAL, especially in high-risk patients.

Severe IAAL >400 mL/min is commonly considered to be treated because the risk of PAL is too high. Standard procedures are usually required in these cases, including parenchymal suturing or stapling.

Postoperatively the use of digital chest drainage systems reduces the inter-operator differences (18) and the overall drainage duration (19). Furthermore, digital monitoring of intrapleural pressure (IPP) can estimate the risk of PAL after VATS lobectomy (14,20,21). Strongly negative IPPs in the first 24 postoperative hours represent a significant predictor of PAL (22,23). The association of significant preoperative and intraoperative risk factors, objective quantification of postoperative AL, and digital monitoring of IPP potentially represent a reliable way to predict PAL in the postoperative course. A postoperative risk stratification model could lead to early treatment of postoperative ALs. Further studies are required to confirm and define its role.

This special Series, "Prolonged Air Leak After Lung Surgery: Prediction, Prevention and Management", published in the *Journal of Thoracic Disease*, aims to present readers with an extensive update on the PAL. We asked each expert to analyze specific aspects by sharing their experience and expertise, such as PAL after robotic surgery and segmentectomy. We have also analyzed the economic impact of PAL through the cost analysis of new devices and complications. Readers can find other interesting insights.

There is still a long way to go to improve our patients' experience; according to Robert Cerfolio, "*no matter how perfectly an operation is performed, still too often an air leak occurs*" (2). Therefore, since our motto is (according to Johann Wolfgang von Goethe) "*the individual alone cannot do much, but many can achieve what they aspire to*", we will continue to try to provide scientific evidence.

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References

1. Droghetti A. The ERAS project for VATS lobectomy-the Italian VATS Group. J Thorac Dis 2018;10:S490.
2. Cerfolio RJ. Commentary: To "Air" is to Leak-To Prevent is Devine. Semin Thorac Cardiovasc Surg 2021;33:595-6.
3. Geraci TC, Chang SH, Shah SK, et al. Postoperative Air Leaks After Lung Surgery: Predictors, Intraoperative Techniques, and Postoperative Management. Thorac Surg Clin 2021;31:161-9.
4. Konstantinidis K, Woodcock-Shaw J, Dinesh P, et al. Incidence and risk factors for 90-day hospital readmission following video-assisted thoracoscopic anatomical lung resection†. Eur J Cardiothorac Surg 2019;55:666-72.
5. Minervini F, Hanna WC, Brunelli A, et al. Outcomes of patients discharged home with a chest tube after lung resection: a multicentre cohort study. Can J Surg 2022;65:E97-103.
6. Zaraca F, Pipitone M, Feil B, et al. Predicting a Prolonged Air Leak After Video-Assisted Thoracic Surgery, Is It Really Possible? Semin Thorac Cardiovasc Surg 2021;33:581-92.
7. Seder CW, Basu S, Ramsay T, et al. A Prolonged Air Leak Score for Lung Cancer Resection: An Analysis of The Society of Thoracic Surgeons General Thoracic Surgery Database. Ann Thorac Surg 2019;108:1478-83.
8. Rivera C, Bernard A, Falcoz PE, et al. Characterization and prediction of prolonged air leak after pulmonary resection: a nationwide study setting up the index of prolonged air leak. Ann Thorac Surg 2011;92:1062-8; discussion 1068.
9. Pompili C, Falcoz PE, Salati M, et al. A risk score to predict the incidence of prolonged air leak after video-assisted thoracoscopic lobectomy: An analysis from the European Society of Thoracic Surgeons database. J Thorac Cardiovasc Surg 2017;153:957-65.
10. Attaar A, Winger DG, Luketich JD, et al. A clinical prediction model for prolonged air leak after pulmonary resection. J Thorac Cardiovasc Surg 2017;153:690-9.e2.
11. Demmy TL. Commentary: 20% Chance of Precipitation. Semin Thorac Cardiovasc Surg 2021;33:593-4.
12. Brunelli A, Bölükbas S, Falcoz PE, et al. Exploring consensus for the optimal sealant use to prevent air leak following lung surgery: a modified Delphi survey from The European Society of Thoracic Surgeons. Eur J Cardiothorac Surg 2021;59:1265-71.
13. Yokota N, Go T, Otsuki Y, et al. A New Method to Identify Air Leaks After Pulmonary Resection Using Indocyanine Green Aerosol. Ann Thorac Surg 2022;114:2067-72.
14. Zaraca F, Vaccarili M, Zaccagna G, et al. Can a standardised Ventilation Mechanical Test for quantitative intraoperative air leak grading reduce the length of hospital stay after video-assisted thoracoscopic surgery lobectomy? J Vis Surg 2017;3:179.
15. Takamochi K, Imashimizu K, Fukui M, et al. Utility of Objective Chest Tube Management After Pulmonary Resection Using a Digital Drainage System. Ann Thorac Surg 2017;104:275-83.
16. Zaraca F, Vaccarili M, Zaccagna G, et al. Cost-effectiveness analysis of sealant impact in management of moderate intraoperative alveolar air leaks during video-assisted thoracoscopic surgery lobectomy: a multicentre randomised controlled trial. J Thorac Dis 2017;9:5230-8.
17. Brunelli A, Salati M, Pompili C, et al. Intraoperative air leak measured after lobectomy is associated with postoperative duration of air leak. Eur J Cardiothorac Surg 2017;52:963-8.
18. Marulli G, Brascia D, De Iaco G, et al. Bubbles-in-the-chamber vs digital screen in chest drainage: A blind analysis of compared postoperative air leaks evaluation. Heart Lung 2021;50:226-30.
19. Zhou J, Lyu M, Chen N, et al. Digital chest drainage is better than traditional chest drainage following pulmonary surgery: a meta-analysis. Eur J Cardiothorac Surg 2018;54:635-43.
20. Brunelli A, Cassivi SD, Salati M, et al. Digital measurements of air leak flow and intrapleural pressures in the immediate postoperative period predict risk of prolonged air leak after pulmonary lobectomy. Eur J Cardiothorac Surg 2011;39:584-8.
21. Refai M, Brunelli A, Varela G, et al. The values of intrapleural pressure before the removal of chest tube in non-complicated pulmonary lobectomies. Eur J Cardiothorac Surg 2012;41:831-3.
22. Bertolaccini L, Viti A, Bertoglio P, et al. Work in progress report of a multicentre retrospective observational study to evaluate the association between the airflows and the intrapleural pressures digitally recorded after video-assisted lobectomy. Interact Cardiovasc Thorac Surg 2021;33:372-6.

23. Eriguchi D, Ito H, Nagashima T, et al. Usefulness of monitoring intrapleural pressure with digital chest drainage system for the management of air leakage after lung resection. Interact Cardiovasc Thorac Surg 2021;33:580-7.

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