



Surgical management of lung abscess: from open drainage to pulmonary resection

Jia-Hao Zhang¹, Shun-Mao Yang^{2,3}, Cheng-Hung How^{3,4}, Yun-Fang Ciou⁵

¹Division of Pulmonary Medicine, Department of Internal Medicine, Far Eastern Memorial Hospital, New Taipei City, Taiwan; ²Department of Surgery, National Taiwan University Hospital, Hsin-Chu Branch, Hsinchu, Taiwan; ³Department of Surgery, National Taiwan University Hospital, Taipei, Taiwan; ⁴Division of Thoracic Surgery, Department of Surgery, Far Eastern Memorial Hospital, New Taipei City, Taiwan; ⁵Department of Fine Arts, National Taiwan Normal University, Taipei, Taiwan

Contributions: (I) Conception and design: SM Yang, CH How; (II) Administrative support: YF Ciou; (III) Provision of study materials or patients: JH Zhang, CH How; (IV) Collection and assembly of data: JH Zhang, SM Yang; (V) Data analysis and interpretation: CH How; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Cheng-Hung How, MD. Division of Thoracic Surgery, Department of Surgery, Far Eastern Memorial Hospital, New Taipei City, Taiwan; Division of Thoracic Surgery, Department of Surgery, National Taiwan University Hospital, Taipei, Taiwan; 7, Chung-Shan South Road, Taipei 10002, Taiwan. Email: chenghung.how@gmail.com.

Abstract: Lung abscess is a type of infectious pulmonary disease, which occurs because of infection and destruction of the pulmonary parenchyma with central necrosis, eventually leading to cavity formation. The characteristic finding of chest roentgenogram is an air-fluid level in the cavitary lesion. In the era without antibiotics, putrid lung abscess was a crushing condition. In the early decades of the 20th century, Neuhof proposed open drainage procedure for infection control of lung abscess, which effectively decreased the mortality rate of lung abscess from 75% to 2.5%. Around 1946, due to the advent of antibiotic, treatment of acute lung abscess with systemic antibiotics showed satisfied outcome. Thereafter, patients received medical treatment with systemic antibiotics rather than surgical management. Medical therapy with systemic antibiotics had become the principal treatment of lung abscess since then. Currently primary management of lung abscess mainly involves proper systemic antibiotics, intensive care, and, if indicated, percutaneous tube thoracostomy drainage. Surgical management for lung abscess became a more challenging task, since indication, timing, and the proper procedure for lung abscess are not well established. Undoubtedly, surgical intervention, including pulmonary resection or decortication procedure, tends to be restricted to those refractories to intensive medical treatment, complicated by life-threatening hemoptysis, pyopneumothorax, or pleural empyema. The primary goal of surgical management is adequate control of the septic focus.

Keywords: Infection; lung abscess; thoracoscopy/video-assisted thoracic surgery; pulmonary resection

Received: 16 September 2018; Accepted: 16 October 2018; Published: 29 October 2018.

doi: 10.21037/jovs.2018.10.14

View this article at: <http://dx.doi.org/10.21037/jovs.2018.10.14>

Introduction

Lung abscesses, necrotizing pneumonia, and lung gangrene, all belong to necrotizing pulmonary infection span with different severity of parenchymal destruction, degree of inflammation, necrosis, and radiographic patterns, although all three can coexist (1). Lung abscess, as an infectious pulmonary disease condition, first described by Hippocrates (2), was characterized by the presence

of a cavity filled with pus or necrotic debris within the parenchyma (3,4). The characteristic radiographic finding of necrotizing pneumonia was consolidation of pulmonary parenchyma with peripheral necrosis and multiple small cavities and which could be rapidly progressed. Central vascular or bronchial obstruction with larger abscess collections was the most typical radiographic finding of lung gangrene (5).

Clinical presentation

Early symptoms and signs of lung abscess could not be clearly distinguished from other pulmonary infection (e.g., pneumonia, necrotizing pneumonia, and lung gangrene) and include cough, dyspnea, fever with chills, chest pain, night sweats, weight loss and fatigue (3). Initially, non-productive was mentioned, but when communication with bronchus appeared, the typical sign was the productive cough (6,7). Sometimes productive cough with hemoptysis was also complained. Clubbing fingers could be found in some patients with chronic lung abscess (3).

Differential diagnosis of cavitary lesion includes excavating tuberculosis and mycosis but seldom can be seen radiological sign of air-fluid level. Localized pleural empyema or pulmonary cystic lesions, such as intrapulmonary sequestration, located bronchial cysts, and emphysematous bullae with secondary infection, would be difficult to be differentiated from lung abscess; however, the localization of lesion, clinical signs and image study (e.g., roentgenogram, computed tomography (CT) scan, ultrasound) could help to make the appropriate diagnosis (3,8).

Microbiology findings

Lung abscess was caused by polymicrobial flora in most cases (9). The etiologic pathogen found in lung abscesses predominant isolated being anaerobic and gram-negative organism. The most commonly isolated organisms are anaerobic bacteria (*Prevotella*, *Bacteroides*, *Fusobacterium*, and *Peptostreptococcus*) or streptococci; on alcoholics with poor oral hygiene, the spectrum of pathogens includes *Staphylococcus aureus*, *Streptococcus pyogenes*, and *Actinomyces* (10,11). During the last decade, *Klebsiella pneumoniae* has been the most isolated bacteria in lung abscess, especially in Taiwan (3,10).

Divisions of lung abscess

According to the duration, lung abscess could be divided into chronic (more than 6 weeks) and acute (less than 6 weeks) (3,12). Depending on whether the underlying lung disease existed, lung abscess could be classified as primary or secondary. Primary lung abscess, occurred without other underlying pulmonary disease and which were a direct result of aspiration or pneumonia (13). Secondary lung abscess was associated with coexisting lung diseases [bronchiectasis, bullous emphysema, cystic fibrosis, infected

pulmonary infarcts, lung contusion or with bronchial obstructions (by foreign body, tumor, or enlarged lymph nodes)] (3). In addition to the direct spreading of broncho-esophageal fistula, subphrenic abscess or pneumonia, the source of pathogenic organism, causing lung abscess, could be from extrapulmonary sites-hematogenous origin due to severe sepsis of liver abscess, septic thromboembolisms or infective endocarditis, etc. (3,14).

Localization of the abscess (affected lung)

The superior segments of the lower lobes or the posterior segments of the upper lobes were predominantly affected area in aspiration pneumonia related lung abscess. The right side was more often affected than the left one. The right lower lobe was the single most frequent location of abscess formation (15). Bilateral or multiple segments involved abscesses were rarely caused by aspiration, and pathogenic organism originated from an extrapulmonary focus by hematogenous spreading due to severe sepsis of intra-abdominal infection, septic thromboembolisms or infective endocarditis should be suspected (16).

Surgical therapy before antibiotic introduction

In the pre-antibiotic era, acute lung abscess was nearly always fatal; 169 of 227 patients admitted into Massachusetts General Hospital for acute lung abscess died in spite of conservative treatment efforts (2). Putrid lung abscess was a life-threatening condition until Doctor Neuhof proposed a novel concept of one-stage open drainage operation for lung abscess in the early decades of the 20th century, which effectively decreased the mortality rate of lung abscess from 75% to 2.5% (12).

Surgical therapy combined with antibiotic treatment

Initial therapy of lung abscess mainly involves proper systemic antibiotics, physiotherapy, and, where indicated, percutaneous tube thoracostomy drainage (17,18). In about 84% of patients received percutaneous tube thoracostomy drainage, as a definitive therapy for lung abscess, had procedure related complication rate about 16% (19). The major complications of tube thoracostomy are spreading of necrotic debris, which would cause subsequent formation of pleural empyema, bronchopleural fistula or procedure related bleeding (20).

Table 1 Indications and complications of invasive intervention

Intervention therapy	Indications	Complications
Open drainage	Alternative treatment in patients with acute lung abscess too sick to undergo pulmonary resection	Air leakage Bronchial fistula Pleural empyema
Percutaneous drainage	Combine with systemic antibiotic as first line therapy under CT or ultrasound guided	Pyopneumothorax/empyema, bronchopleural fistula, and bleeding Tube malposition Subcutaneous emphysema
Pulmonary resection (wedge resection, lobectomy, and pneumonectomy)	Acute indication: hemoptysis, prolonged sepsis, refractory medical response, bronchopleural fistula, and localized infections lesion Chronic indication: unsuccessfully treated lung abscess for more than 6 weeks, suspicion on cancer, cavitary >6 cm, refractory to antibiotic treatment	Post-operative pneumonia Empyema Mediastinitis Post-operative air leakage (>7 days) Stump leak or bronchopleural fistula Arrhythmia
Decortication/debridement	Rupture of abscess in the pleural cavity with pyopneumothorax/empyema	Post-operative air leakage (>7 days) Bronchopleural fistula Residual debris

However, not all patients respond to non-operative management (21). If antibiotics fail to achieve the therapeutic concentration in the infected tissue, parenchymal destruction may worsen, and infection may progress, possibly resulting in life-threatening hemoptysis, bronchopleural fistula, and profound shock. If liquified necrosis of infected parenchyma broke through visceral pleura, subsequent formation of pleural empyema may occur (22).

Nowadays, surgical management for lung abscess became a more difficult challenge, since currently neither timing nor indication of related surgical procedure is well established (15). Surgical managements and outcomes are complicated by numerous factors, including underlying comorbidity, severity of lung injury, procedure of intervention required, and whether a residual space is present or anticipated (15).

Undoubtedly, aggressive resection of the necrotic pulmonary parenchyma or decortication of pleura has been considered lifesaving in cases of refractory to intensive medical management, but complicated by life-threatening

hemoptysis, pyopneumothorax, or pleural empyema (23-25).

Surgical resection of lung abscess is the therapy of choice for about 10% of patients (3). Resuscitating and stabilizing patients suffered from acute lung abscess with empyema by thoracic decortication before lung resection were advised (26). Dissection of the hilar structure in the presence of pleural empyema can lead to mediastinitis or bronchopleural fistula and should be avoided (27). Indications and associated complications of surgical management for lung abscess were summarized in *Table 1*. Indications of surgical management are as following: refractory to intensive medical therapy, cavitary lesion >6 cm in diameter, life-threatening hemoptysis, bronchopleural fistula, and rupture of abscess in the pleural cavity with pleural empyema (15).

To our best knowledge, the definition of massive hemoptysis was varied from 200 to 1,000 mL/day (28). As an alternative, hemoptysis should be classified due to its severity and life-threatening circumstance instead of its quantity (28). Hemoptysis could be bleeding from pulmonary or bronchial artery system. Bleedings of

bronchial artery system usually occur as a consequence of neovascularization and accompany inflammatory pulmonary diseases. Massive and typically fatal hemorrhage of pulmonary artery may be the result of mechanical damage formed by lung cancer, aspergilloma, or necrotizing pneumonia (29,30). Lung abscess with life-threatening hemoptysis was rare but was an emergent condition for pulmonary resection. Eradicating the affected lesions and achieving hemostasis simultaneously by pulmonary resection was the treatment of choice of life-threatening hemoptysis (28).

The goal of surgical management of localized infectious disease is to eradicate necrotic debris of lung abscess which could be a reservoir or nidus for recurrent infection (31). Lobectomy was proposed for central localized or large cavity of lung abscess (27). Atypical pulmonary resection or segmentectomy were enough, if it is possible to eradicate the affected lesions of abscess completely and, if necessary, the surrounding lung tissue with adequate resection margin (32).

Although Schweigert *et al.* suggest that no significant association between the extent of the surgical resection (segmentectomy, lobectomy, pneumonectomy) and the outcome (15). Complications of limited resection for localized pulmonary necrosis had been mentioned by several studies. The most common complications for patients who underwent wedge resections were recurrent pulmonary infection due to insufficient resection range, and residual infectious tissue may contribute to pulmonary complications, regardless of open thoracotomy or video-assisted thoracic surgery (VATS) approach (33). For patients receiving pulmonary resection, elderly patients were not associated with higher mortality rate (15,34,35). Significant prognostic factors for fatal outcome are pulmonary sepsis, septic complications (air leak, pleural empyema), septic organ failure (respiratory, acute renal failure), and preexisting comorbidity (Charlson index of comorbidity ≥ 3) (15).

Conclusions

Lung abscess remains a life-threatening condition with substantial morbidity and mortality. Lung abscess had become a domain of medical treatment with appropriate systemic antibiotics, physiotherapy, and, if where indicated, percutaneous tube thoracostomy drainage. Surgical interventions, including open drainage, decortication, or pulmonary resection, still play an important role for complicated lung abscess (e.g., refractory to broad spectrum

antibiotic treatment, prolonged antibiotic treatment course, life-threatening hemoptysis, and ruptured abscess with empyema). Early detection of medical therapy failure and adequate control of the septic focus by pulmonary resection of all necrotic tissue are the primary goals of surgical therapy.

Acknowledgments

Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned by the Guest Editor (Kamran Ali) for the series “Asia Thoracoscopic Surgery Education Program (ATEP) Special Issue on Inflammatory Thoracic Diseases” published in *Journal of Visualized Surgery*. The article has undergone external peer review.

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at <http://dx.doi.org/10.21037/jovs.2018.10.14>). The series “Asia Thoracoscopic Surgery Education Program (ATEP) Special Issue on Inflammatory Thoracic Diseases” was commissioned by the editorial office without any funding or sponsorship. The authors have no other conflicts of interest to declare.

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.

Open Access Statement: This is an Open Access article distributed in accordance with the Creative Commons Attribution-NonCommercial-NoDerivs 4.0 International License (CC BY-NC-ND 4.0), which permits the non-commercial replication and distribution of the article with the strict proviso that no changes or edits are made and the original work is properly cited (including links to both the formal publication through the relevant DOI and the license). See: <https://creativecommons.org/licenses/by-nc-nd/4.0/>.

References

1. Reimel BA, Krishnadasen B, Cuschieri J, et al. Surgical management of acute necrotizing lung infections. *Can*

- Respir J 2006;13:369-73.
2. Schweigert M, Dubecz A, Stadlhuber RJ, et al. Modern history of surgical management of lung abscess: from Harold Neuhof to current concepts. *Ann Thorac Surg* 2011;92:2293-7.
 3. Kuhajda I, Zarogoulidis K, Tsirgogianni K, et al. Lung abscess-etiology, diagnostic and treatment options. *Ann Transl Med* 2015;3:183.
 4. Seo H, Cha SI, Shin KM, et al. Focal necrotizing pneumonia is a distinct entity from lung abscess. *Respirology* 2013;18:1095-100.
 5. Krishnadasan B, Sherbin VL, Vallieres E, et al. Surgical management of lung gangrene. *Can Respir J* 2000;7:401-4.
 6. Chan PC, Huang LM, Wu PS, et al. Clinical management and outcome of childhood lung abscess: a 16-year experience. *J Microbiol Immunol Infect* 2005;38:183-8.
 7. Yen CC, Tang RB, Chen SJ, et al. Pediatric lung abscess: a retrospective review of 23 cases. *J Microbiol Immunol Infect* 2004;37:45-9.
 8. Lin FC, Chou CW, Chang SC. Differentiating pyopneumothorax and peripheral lung abscess: chest ultrasonography. *Am J Med Sci* 2004;327:330-5.
 9. Yazbeck MF, Dahdel M, Kalra A, et al. Lung abscess: update on microbiology and management. *Am J Ther* 2014;21:217-21.
 10. Takayanagi N, Kagiya N, Ishiguro T, et al. Etiology and outcome of community-acquired lung abscess. *Respiration* 2010;80:98-105.
 11. Marra A, Hillejan L, Ukena D. Management of Lung Abscess. *Zentralbl Chir* 2015;140 Suppl 1:S47-53.
 12. Neuhof H, Hurwitt E. Acute Putrid Abscess of the Lung: Vii. Relationship of the Technic of the One-Stage Operation to Results. *Ann Surg* 1943;118:656-64.
 13. Nicolini A, Cilloniz C, Senarega R, et al. Lung abscess due to *Streptococcus pneumoniae*: a case series and brief review of the literature. *Pneumonol Alergol Pol* 2014;82:276-85.
 14. Puligandla PS, Laberge JM. Respiratory infections: pneumonia, lung abscess, and empyema. *Semin Pediatr Surg* 2008;17:42-52.
 15. Schweigert M, Solymosi N, Dubecz A, et al. Predictors of Outcome in Modern Surgery for Lung Abscess. *Thorac Cardiovasc Surg* 2017;65:535-41.
 16. Moreira Jda S, Camargo Jde J, Felicetti JC, et al. Lung abscess: analysis of 252 consecutive cases diagnosed between 1968 and 2004. *J Bras Pneumol* 2006;32:136-43.
 17. Davis B, Systrom DM. Lung abscess: pathogenesis, diagnosis and treatment. *Curr Clin Top Infect Dis* 1998;18:252-73.
 18. Hirshberg B, Sklair-Levi M, Nir-Paz R, et al. Factors Predicting Mortality of Patients With Lung Abscess. *Chest* 1999;115:746-50.
 19. Wali SO, Shugaeri A, Samman YS, et al. Percutaneous drainage of pyogenic lung abscess. *Scand J Infect Dis* 2002;34:673-9.
 20. Pagès PB, Bernard A. Lung abscess and necrotizing pneumonia: chest tube insertion or surgery?. *Rev Pneumol Clin* 2012;68:84-90.
 21. Schweigert M, Giraldo Ospina CF, Solymosi N, et al. Emergent pneumonectomy for lung gangrene: does the outcome warrant the procedure? *Ann Thorac Surg* 2014;98:265-70.
 22. Fujimoto R, Omasa M, Ishikawa H, et al. Surgery of a nocardia lung abscess presenting as a tension pyopneumothorax. *Asian Cardiovasc Thorac Ann* 2017;25:315-7.
 23. Tsai YF, Tsai YT, Ku YH. Surgical treatment of 26 patients with necrotizing pneumonia. *Eur Surg Res* 2011;47:13-8.
 24. Chen CH, Huang WC, Chen TY, et al. Massive necrotizing pneumonia with pulmonary gangrene. *Ann Thorac Surg* 2009;87:310-1.
 25. Pfitzner J, Peacock MJ, Tsirgiotis E, et al. Lobectomy for cavitating lung abscess with haemoptysis: strategy for protecting the contralateral lung and also the non-involved lobe of the ipsilateral lung. *Br J Anaesth* 2000;85:791-4.
 26. Odell JA, Buckels NJ. Techniques of pneumonectomy. Pneumonectomy through an empyema. *Chest Surg Clin N Am* 1999;9:369-78, x-xi.
 27. Refaely Y, Weissberg D. Gangrene of the lung: treatment in two stages. *Ann Thorac Surg* 1997;64:970-3;discussion 973-4.
 28. Kiral H, Evman S, Tezel C, et al. Pulmonary resection in the treatment of life-threatening hemoptysis. *Ann Thorac Cardiovasc Surg* 2015;21:125-31.
 29. Jougon J, Ballester M, Delcambre F, et al. Massive hemoptysis: what place for medical and surgical treatment. *Eur J Cardiothorac Surg* 2002;22:345-51.
 30. Jean-Baptiste E. Clinical assessment and management of massive hemoptysis. *Crit Care Med* 2000;28:1642-7.
 31. Schuchert MJ, Pettiford BL, Keeley S, et al. Anatomic segmentectomy in the treatment of stage I non-small cell lung cancer. *Ann Thorac Surg* 2007;84:926-32;discussion 932-33.
 32. Sun Y, Hou L, Xie H, et al. Wedge resection for localized infectious lesions: high margin/lesion ratio guaranteed operational safety. *J Thorac Dis* 2014;6:1173-9.

33. Mitchell JD, Yu JA, Bishop A, et al. Thoracoscopic lobectomy and segmentectomy for infectious lung disease. *Ann Thorac Surg* 2012;93:1033-9;discussion 1039-40.
34. Maldonado F, Daniels CE, Hoffman EA, et al. Focal organizing pneumonia on surgical lung biopsy: causes, clinicoradiologic features, and outcomes. *Chest* 2007;132:1579-83.
35. Mwandumba HC, Beeching NJ. Pyogenic lung infections: factors for predicting clinical outcome of lung abscess and thoracic empyema. *Curr Opin Pulm Med* 2000;6:234-9.

doi: 10.21037/jovs.2018.10.14

Cite this article as: Zhang JH, Yang SM, How CH, Ciou YF. Surgical management of lung abscess: from open drainage to pulmonary resection. *J Vis Surg* 2018;4:224.