# $S^1$ segmentectomy for early stage NSCLC in the apical segment of the right upper lobe

**Luigi Ventura[1#], Chunyu Ji[2#], Weigang Zhao[2], Xuefei Zhang[2], Wentao Fang[2]**

[1]Thoracic Surgery, Surgical Unit, Department of Medicine and Surgery, University Hospital of Parma, Parma, Italy; [2]Department of Thoracic Surgery, Shanghai Chest Hospital, Jiaotong University Medical School, Shanghai 200032, China

[#]These authors contributed equally to this work.

*Correspondence to:* Wentao Fang. Department of Thoracic Surgery, Shanghai Chest Hospital, Jiaotong University Medical School, Shanghai 200032, China. Email: vwtfang@hotmail.com.

**Abstract:** In the last years, the role of segmentectomy for the treatment of patient with early stage lung cancer is gaining more and more importance. Compared to lobectomy, performing a segmentectomy needs more surgical experience and anatomical knowledge, in particular if individual upper and lower lobe segmentectomies are considered. Here, we present a case of a patient with a minimally invasive adenocarcinoma (MIA) in the $S^1$ segment of the right upper lobe treated with an apical ($S^1$) segmentectomy. A 54-year-old female patient came to our attention with a chest CT-scan finding of an 8.8 mm subsolid nodule in the $S^1$ segment of the right upper lobe. As we considered the lesion highly suspicious of early stage lung cancer, a surgical excision was proposed. A right $S^1$ segmentectomy by minimally invasive approach was performed. The post-operative course was uneventful, and the patient was discharged on the 4$^{th}$ post-operative day. Final histopathological examination revealed a MIA of the lung, staged as pT1miN0M0. In the treatment of patients with early stage lung cancer located in $S^1$ segment of the right upper lobe, video-assisted thoracoscopic surgery (VATS) $S^1$ segmentectomy represents a safe and radical therapeutic procedure which allows to spare the remaining segments of the right upper lobe.

**Keywords:** Video-assisted thoracoscopic surgery (VATS); VATS segmentectomy; sublobar resection; segmentectomy; lung cancer

Received: 17 May 2018; Accepted: 21 June 2018; Published: 13 July 2018.

doi: 10.21037/jovs.2018.06.14

**View this article at:** http://dx.doi.org/10.21037/jovs.2018.06.14

## Introduction

Lobectomy together with lymph node dissection or systemic sampling has been considered the standard procedure for patients with early stage lung cancer (1). Limited resections such as wedge resection or segmentectomy are only considered in high-risk patients with compromised functional status. However, with the introduction of high-resolution computed tomography (HRCT) screening, detection of small-sized (<2 cm) ground glass opacities (GGO) suggestive of adenocarcinoma in situ (AIS) or minimally invasive adenocarcinoma (MIA) has significantly increased in recent years (2,3). Considering the relatively indolent nature of the disease and the rarity of lymphatic involvement, there has been a reviving interest in sublobar resections such as segmentectomies (4). A significant number of reports comparing lobectomy and segmentectomy has appeared, showing that segmentectomy may be oncologically equivalent to lobectomy in terms of recurrence and survival for early stage lung cancers without nodal involvement (5-9). In addition, segmentectomy was certainly an acceptable procedure for patients with metastatic lung lesions arising from other malignancies such as colon cancers (10,11) and non-malignant diseases, such as severe haemoptysis (12), pulmonary arteriovenous fistulas (13), congenital bronchial atresia (14), intralobar pulmonary sequestration (15), inflammatory pseudotumors (16).

Video-assisted thoracoscopic surgery (VATS) has been well established as the recommended surgical approach for


**Figure 1** Three-port VATS right apical ($S^1$) segmentectomy for a MIA in the apical segment of the right upper lobe (30). VATS, video-assisted thoracoscopic surgery; MIA, minimally invasive adenocarcinoma.

Available online: http://www.asvide.com/article/view/25827

early stage lung cancers (17). Its benefits over thoracotomy have already been demonstrated in decreased postoperative pain, shortened chest-tube duration, shortened length of hospital stay, faster return to preoperative activity levels, and better preserved pulmonary function (17-20). When compared to segmentectomy by open approach, VATS segmentectomy for stage I NSCLC has been shown to be feasible, safe, and associated with reduced perioperative mortality and equivalent or improved overall survival (20-26). VATS segmentectomy is generally preferred to open lobectomy in patients with poor cardio-pulmonary function, as it helps to minimize the invasiveness of surgery and preserve pulmonary function (27). The combination of limited resection and minimally invasive surgery, therefore, represents a great step forward in modern thoracic surgery. However, the most commonly performed typical segmentectomies are relatively easier and larger segments, such as lingula-sparing left upper lobectomy (apical trisegmentectomy), lingular segmentectomy, and resection of the superior segments of bilateral lower lobes ($S^6$). Other single segment resections, especially those difficult and atypical segmentectomies are technically more demanding and thus less practiced (28,29). We hereby present a case of an apical segment resection ($S^1$ segmentectomy) for a patient with a MIA in the right upper lobe.

## Patient and methods

A 54-year-old female patient presented a year and half ago with an 8.8 mm mixed GGO in the $S^1$ segment of the right upper lobe detected on CT scan for physical check-up. She was in good clinical condition, with no smoking history and no significant past clinical history. The nodule remained almost unchanged on follow-up CT scans. Although her serum tumor markers were within normal range, PET scan showed a slight FDG uptake. Early stage lung cancer was suspected, and surgical excision was suggested to remove the lesion for treatment and diagnosis. Informed consent of the patient was acquired before surgery. Considering that the lesion was a subsolid nodule less than 1 cm and with a slow growth pattern, a $S^1$ segmentectomy instead of a standard right upper lobectomy was proposed. Two hours before the operation, a hook wire was inserted percutaneously into the lesion under CT-guidance. After induction and a double-lumen intubation, the patient was placed in a left decubitus position, with her right arm abducted and suspended on a frame above her head. A routine three-port VATS approach was selected. In the *Figure 1*, we show the surgical procedure. First, a camera port was created in the mid-axillary line in the $7^{th}$ intercostal space, and a 10-mm 30-degree thoracoscope was introduced through an ordinary trocar for exploration. Under the guidance of the camera, a 4 cm working port in the anterior axillary line in the $4^{th}$ intercostal space, and a 2 cm assisting port in the posterior axillary line in the $8^{th}$ intercostal space were created. Upon exploration, the lesion was confirmed to be located in the middle of the $S^1$ segment according to the position of the hook wire. Therefore, we proceeded with the planned $S^1$ segmentectomy believing that sufficient resection margin could be obtained. First, the hilum of the right upper lobe was exposed with a harmonic scalpel, to reveal anteriorly the superior pulmonary vein and the truncus superior artery with its branches to the anterior ($A^3$) and apical ($A^1$) segments, and posteriorly the bifurcation between the upper lobar bronchus and the intermedius bronchus. An important trick is to expose the vessels of the targeted segment as distally as possible, so that the lung could be removed together with the hilar structures and to make an anatomical segmentectomy instead of a big wedge resection. This will also help to achieve a maximum resection margin. The vein for the apical segment of the RUL ($V^1$) was ligated with suture tie and a hemolock cordially, and then closed with a hemolock as distally as possible. So, when $V^1$ was divided with harmonic scalpel, the pulmonary artery branch to the anterior segment ($A^3$) could be clearly exposed and protected. Double ligation with suture and hemolock is preferred over stapling devices during segmentectomies, as it not only reduces cost, but also saves time and it helps

 

to avoid accidental injuries often associated with passing a stapler around the vessels. Identifying pulmonary arteries for the apical segment of the RUL could be quite tricky, as sometimes there is a recurrent branch to the posterior segment (Rec. $A^2$) originating from the truncus superior artery. But, when the ventral branch of $A^1$ ($A^1$b) was first divided, differentiating the dorsal branch of $A^1$ ($A^1$a) from a recurrent $A^2$ becomes much easier. A recurrent $A^2$ usually runs away from $B^1$, while $A^1$a runs along it into the $S^1$ parenchyma. In this case there was no recurrent $A^2$ and $A^1$a was then divided in a similar way to $A^1$b. After removing the lymph nodes (station 12) between the pulmonary artery and the upper lobe bronchus, the apical segmental bronchus ($B^1$) could then be exposed. But, before dividing $B^1$, it is always important to double-check if it is indeed the correct bronchus to the apical segment. To do this, $B^1$ was clamped with a stapler in place and the right lung was inflated by the anaesthesiologist. The $S^1$ segment would remain collapsed while the rest of the right upper lobe ($S^2$ and $S^3$) would re-expand. After, the stapler was fired to divide B1. Then, the distal end of $B^1$ was lifted with a sponge clamp and the surrounding lung parenchyma was dissected away from the hilum along the preserved neighbouring structures ($A^3$ and $B^3$). After hilum dissection had been completed, the anaesthesiologist was asked to inflate the right lung again. This helped to create a clear inflation-deflation line between the $S^1$ to be resected and the inflated remaining lung. When technically possible, it is also helpful to use the intersegmental pulmonary vein to guide the cutline between $S^1$ and $S^{2-3}$. Then, $S^1$ was resected with endoscopic staplers. To do this, the anvil of the stapler was placed right in between the divided stumps of the hilar structures (bronchus and vessels), and the cartridge was oriented along the inflation-deflation line in the surface of the lung. Before the first and second fire, anaesthesiologist was again asked to inflate the lung to avoid inadvertent injury to the neighbouring segmental bronchus. Finally, the resected segment was removed in an endoscopic retrieving bag through the working port and sent for frozen section. For small, subsolid lesions, systemic lymph node dissection is not necessary because of a very low involvement rate. So, only hilar and superior mediastinal nodes were sampled for the staging purpose.

## Role of members of our multi-disciplinary team

The members of our multi-disciplinary team include: nurses, radiologists, anaesthesiologists, assistant holding the thoracoscope (usually a junior surgeon in training), assistant surgeon and main surgeon. Radiologists are important during the analysing process of the CT scan and then, if necessary, to mark the nodule by inserting the hook wire in the pulmonary lesion. The anaesthesiologist is clearly important to ensure a good general anaesthesia of the patient, a good selective bronchial intubation and finally a good coordination with the surgeon during the re-expansion of the lung, to guarantee a good inflation-deflation line between the segment to remove and the remaining lung. The anaesthesiologist can also help the surgeon to localize the targeted segmental bronchus using a flexible bronchoscope.

The three surgeons, with different roles, are clearly important to perform the surgical resection of the pulmonary segment, in a constant process of interaction during the entire surgical procedure.

## Results

The post-operative course was uneventful, and the patient was discharged on the 4$^{th}$ post-operative day. Final histopathological examination revealed a MIA of 8 mm, staged as pT1miN0M0 according to the 8$^{th}$ UICC staging system. No additional treatment was considered necessary and the patient was put under routine follow-up.

## Conclusions

$S^1$ segmentectomy represents a safe and acceptable therapeutic procedure for small, low grade, early stage lung cancers and other metastatic or benign lesions located in the peripheral part of the apical segment of the right lung. Comparing to wedge resection, it helps to ensure enough resection margin and the removal of intersegmental and hilar lymph nodes; comparing to a standard lobectomy, it may also diminish pulmonary function loss by sparing lung parenchyma. The combination of limited resection and minimally invasive approach is thus beneficial to selected patient, when surgical and oncological principles could be observed.

## Acknowledgments

*Funding:* None.

## Footnote

*Provenance and Peer Review:* This article was commissioned

 

by the Guest Editor (Alessandro Brunelli) for the series "Uncommon Segmentectomies" 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.2018.06.14). The series "Uncommon Segmentectomies" 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. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Informed consent of the patient was acquired before surgery.



## References

1. Ginsberg RJ, Rubinstein LV. Randomized trial of lobectomy versus limited resection for T1N0 non-small cell lung cancer. Lung Cancer Study Group. Ann Thorac Surg 1995;60:615-22; discussion 622-3.
2. National Lung Screening Trial Research Team, Aberle DR, Adams AM, et al. Reduced lung-cancer mortality with low-dose computed tomographic screening. N Engl J Med 2011;365:395-409.
3. Travis WD, Brambilla E, Noguchi M, et al. International Association for the Study of Lung Cancer/American Thoracic Society/European Respiratory Society international multidisciplinary classification of lung adenocarcinoma. J Thorac Oncol 2011;6:244-85.
4. Asamura H, Hishida T, Suzuki K, et al. Radiographically determined non-invasive adenocarcinoma of the lung: Survival outcomes of Japan Clinical Oncology Group 0201. J Thorac Cardiovasc Surg 2013;146:24-30.
5. Martin-Ucar AE, Delgado Roel M. Indication for VATS sublobar resections in early lung cancer. J Thorac Dis 2013;5 Suppl 3:S194-9.
6. Altorki NK, Kamel MK, Narula N, et al. Anatomical segmentectomy and wedge resections are associated with comparable outcomes for patients with small cT1N0 non-small cell lung cancer. J Thorac Oncol 2016;11:1984-92.
7. Fiorelli A, Caronia FP, Daddi N, et al. Sublobar resection versus lobectomy for stage I non-small cell lung cancer: an appropriate choice in elderly patients? Surg Today 2016;46:1370-82.
8. Bao F, Ye P, Yang Y, et al. Segmentectomy or lobectomy for early stage lung cancer: a meta-analysis. Eur J Cardiothorac Surg 2014;46:1-7.
9. Zhang L, Li M, Yin R, et al. Comparison of the oncologic outcomes of anatomic segmentectomy and lobectomy for early-stage non-small cell lung cancer. Ann Thorac Surg 2015;99:728-37.
10. Shiono S, Okumura T, Boku N, et al. Outcomes of segmentectomy and wedge resection for pulmonary metastases from colorectal cancer. Eur J Cardiothorac Surg 2017;51:504-10.
11. Berry MF. Role of segmentectomy for pulmonary metastases. Ann Cardiothorac Surg 2014;3:176-82.
12. 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.
13. Nakamura H, Miwa K, Haruki T, et al. Pulmonary arteriovenous fistula with cerebral infarction successfully treated by video-assisted thoracic surgery. Ann Thorac Cardiovasc Surg 2008;14:35-7.
14. Igai H, Kamiyoshihara M, Nagashima T, et al. Anatomical segmentectomy for pneumothorax associated with congenital bronchial atresia. Eur J Cardiothorac Surg 2013;43:198.
15. Inoue T, Oizumi H, Nakamura M, et al. Port-access thoracoscopic anatomical segmentectomy for pediatric intralobar pulmonary sequestration. Thorac Cardiovasc Surg Rep 2014;3:42-4.
16. Melloni G, Carretta A, Ciriaco P, et al. Inflammatory pseudotumor of the lung in adults. Ann Thorac Surg 2005;79:426-32.
17. Bendixen M, Jørgensen OD, Kronborg C, Andersen C, Licht PB. Postoperative pain and quality of life after lobectomy via video-assisted thoracoscopic surgery or

anterolateral thoracotomy for early stage lung cancer: a randomised controlled trial. Lancet Oncol 2016;17:836-44.
18. Kaseda S, Aoki T, Hangai N, et al. Better pulmonary function and prognosis with video-assisted thoracic surgery than with thoracotomy. Ann Thorac Surg 2000;70:1644-6.
19. Atkins BZ, Harpole DH Jr, Mangum JH, et al. Pulmonary segmentectomy by thoracotomy or thoracoscopy: Reduced hospital length of stay with a minimally-invasive approach. Ann Thorac Surg 2007;84:1107-12; discussion 1112-3.
20. Jawitz OK, Wang Z, Boffa DJ, Detterbeck FC, Blasberg JD, Kim AW. The differential impact of preoperative comorbidity on perioperative outcomes following thoracoscopic and open lobectomies. Eur J Cardiothorac Surg 2017;51:169-74
21. Leshnower BG, Miller DL, Fernandez FG, et al. Video-assisted thoracoscopic surgery segmentectomy: a safe and effective procedure. Ann Thorac Surg 2010;89:1571-6.
22. Shiraishi T, Shirakusa T, Iwasaki A, et al. Video-assisted thoracoscopic surgery (VATS) segmentectomy for small peripheral lung cancer tumors: intermediate results. Surg Endosc 2004;18:1657-62.
23. Schuchert MJ, Pettiford BL, Pennathur A, et al. Anatomic segmentectomy for stage I non-small-cell lung cancer: comparison of video-assisted thoracic surgery versus open approach. J Thorac Cardiovasc Surg 2009;138:1318-25.e1
24. Deen SA, Wilson JL, Wilshire CL, et al. Defining the cost of care for lobectomy and segmentectomy: a comparison of open, video-assisted thoracoscopic, and robotic approaches. Ann Thorac Surg 2014;97:1000-7.
25. Smith CB, Kale M, Mhango G, et al. Comparative outcomes of elderly stage I lung cancer patients treated with segmentectomy via video-assisted thoracoscopic surgery versus open resection. J Thorac Oncol 2014;9:383-9.
26. Ghaly G, Kamel M, Nasar A, et al. Video-Assisted Thoracoscopic Surgery Is a Safe and Effective Alternative to Thoracotomy for Anatomical Segmentectomy in Patients with Clinical Stage I Non-Small Cell Lung Cancer. Ann Thorac Surg 2016;101:465-72; discussion 472.
27. Keenan RJ, Landreneau RJ, Maley RH Jr, et al. Segmental resection spares pulmonary function in patients with stage I lung cancer. Ann Thorac Surg 2004;78:228-33.
28. Pham D, Balderson S, D'Amico T. Technique of Thoracoscopic Segmentectomy. Oper Tech Thorac Cardiovasc Surg 2008;13:188-203.
29. D'Amico TA. Thoracoscopic segmentectomy: technical considerations and outcomes. Ann Thorac Surg 2008;85:S716-8.
30. Ventura L, Ji C, Zhao W, et al. Three-port VATS right apical (S1) segmentectomy for a MIA in the apical segment of the right upper lobe. Asvide 2018;5:614. Available online: http://www.asvide.com/article/view/25827

doi: 10.21037/jovs.2018.06.14
**Cite this article as:** Ventura L, Ji C, Zhao W, Zhang X, Fang W. $S^1$ segmentectomy for early stage NSCLC in the apical segment of the right upper lobe. J Vis Surg 2018;4:141.

 