Case report

Surgical outcome of combined subsegmentectomy in the right upper lobe for GGO-dominant early stage lung cancer: Analysis of 7 cases

Keigo Okamoto*, Jun Hanaoka

Division of Cardiovascular and Thoracic Surgery, Shiga University of Medical Science, Seta Tsukinowa-cho, Otsu, Shiga 520-2192, Japan

ARTICLE INFO

Keywords:
- Non-small cell lung cancer
- Lung adenocarcinoma
- Surgery
- Subsegmentectomy
- CSS

ABSTRACT

Combined subsegmentectomy (CSS) is procedure as diagnostic purpose adding sufficient surgical margin. Compared to other procedure, CSS is not common, with the surgical results also being controversial. We analyzed the patients who had undergoing CSS in the right upper lobe for ground glass opacity (GGO)-dominant nodules. Between April 2011 and March 2017, we experienced 7 cases underwent CSS. In all cases, three subsegments resection and lymph node dissection using Video-Assisted Thoracic Surgery (VATS) was performed. The mean radiological tumor size was 1.4 (1.1–1.9) cm and the mean consolidation/tumor ratios was 19 (0–33) %. Pathological diagnosis was all t1a-pIA1 adenocarcinoma in all cases, curative resection was obtained with sufficient margin. There were no serious postoperative complications or death within 90 days after treatment. Unfortunately, one patient died of pneumonia 28 months after surgery, but there was no recurrence and other delayed adverse events (follow up period was mean 42.8 months). We conclude that CSS had effects on both tumor control and preservation of the residual lungs with tolerable complications.

1. Introduction

In recent years, advances in the imaging examination have revealed the small pulmonary lesions and led to the accurate detection of early stage lung cancer [1]. If the preoperative histological diagnosis of lung cancer is confirmed, standard lobectomy and node dissection is indicated, and if not confirmed, diagnostic lung resection will be performed. Such lesions often require anatomical lung resection for some reason (not palpable, near the central region of the thorax or close to the pulmonary vessels, etc.), which is a further dilemma for surgeons. Also, we have felt as a clinical problem in especially right upper lobe from before. Therefore, we have performed combined subsegmentectomy (CSS) for central small pulmonary lesion which was suspected lung cancer as a diagnostic purpose adding sufficient surgical margin.

CSS, which resects the segment with the adjacent subsegment may be able to guarantee both preservation of residual lung and therapeutic effect by keeping surgical margin. Compared to other anatomical lung resection procedure, this complicated procedure has few reports. In this time, we retrospectively reviewed our 7 patients underwent right upper lobe CSS and analyzed their clinical outcomes.

2. Case presentation

Between April 2011 and March 2017, we experienced seven right upper lobe CSS (Table 1). The median age was 67 years (range, 53–85), and there was only one male. Patients condition including performance status was generally good. 2 patients with accompanying respiratory disease were well managed with inhaled medicine. Spirometry abnormalities included 2 patients, with 1 having a vital capacity (VC) of less than 80% and 1 with a forced expiratory volume in 1 s (FEV1)/functional vital capacity (FVC) of less than 70% (patient had emphysema).

Chest computed tomography (CT) revealed ground glass opacity (GGO)-dominant nodules, that were located near the central region of the lung where wedge resection was supposed to be difficult, in all cases (Fig. 1). The mean tumor diameter was 1.4 (1.1–1.9) cm and the mean CTRs (consolidation/tumor ratios) was 19 (0–33) % (Table 2). In all cases, the preoperative diagnosis was not confirmed and underwent CSS for diagnostic purpose and expectation of treatment (see Fig. 2).

In all cases, three subsegments resection and lymph node dissection (ND1b) using Video-Assisted Thoracic Surgery (VATS) was performed (Table 2). The mean operation time and blood-loss were 310 (258–389) mins and 106 (25–202) g. There was no case required conversion to thoracotomy (open surgery) or transfusion therapy. All patients
underwent curative resection (R0) with surgical margin equal to or greater than tumor diameter. Chest drain removal was done on mean 3 (1–5) day after surgery, and there was no case of prolonged air leak. No postoperative complication beyond grade 3 classified by Clavien-Dindo classification.

The pathological finding was shown in Table 2. Classified by TNM 8th edition, pathological diagnosis was t1a-pIA adenocarcinoma in all cases. Postoperative observation period was mean 42.8 (18–72) months. During the follow-up, all patients was free from neither local nor distant recurrence. Unfortunately, one patient died of pneumonia, but not shown tumor recurrence.

3. Discussion

Segmentectomy is often adapted for undiagnosed small pulmonary lesion as diagnostic purpose. For lung cancer, several studies have reported [2–6], been adapted as limited lung resection. Excluding the right middle lobe, segmentectomy in the left upper lobe and both lower lobes has been standardized, but in the right upper right lobe it is cumbersome due to its anatomical complexity. Also, due to the number of segments is small, lobectomy is often adapted for diagnosis, so much discussion about the significance of CSS had not been made. We believe that our study leads advanced knowledge by revealing unresolved issues pertaining to CSS.

Subsegmentectomy and CSS are not common procedures compared to segmentectomy, and there has been few previous reports. In our study, patients were recurrence-free including local recurrence during the follow-up. Survival time was also acceptable. Because they had not received adjuvant therapy, the treatment effect seems to be from surgery alone. Although GGO-dominant tumors with low CTRs are known as non-aggressive lung adenocarcinomas [7,8], Suzuki et al. reported that even if the tumors had low CTRs, there was still a possibility of cases with the presence of pathological-invasive components [9]. In our population, the maximum CTRs was 0.33. But one patient with lower CTRs had pathological invasive component (Case No. 4). Therefore, 3 subsegments resected with CSS may be an adequate volume to obtain cure for smaller than 2 cm and N0 stage tumors.

To identify accurate segmental and subsegmental division, we used the air-collapse line or/and a fluorescence imaging video system with indocyanine green (ICG), besides vessel travel as guidance. Although these techniques slightly affected the operation time extension, it seems that it brought about the effect of avoiding local recurrence any more. Another argument is the influence on residual lung. CSS procedure required more surgical attention to smaller structures, and operation time tended to prolong a little. On the other hand, there was not much intraoperative bleeding, and it was possible to perform surgery safety by VATS approach. Postoperative complications involving invasive treatment was also none. Prolonged air leakage is often a problem after sublobar resections [10], there were no patients in which air leakage was prolonged or relapsed after drain removal.

It is also important that there is no decrease in lung volume due to atelectasis or bronchial stenosis. If there was a lack of blood flow or ventilation, residual lungs should had been affected by organizing and roughening. In fact, such findings were not seen in postoperative CT. With the except for one patient, no postoperative delayed adverse events occurred. In other words, CSS, resecting 3 subsegments could have maintained good ventilation-blood flow redistribution for residual lungs. Although routine spirometry was necessary for detailed evaluation, it could not be performed in all patients. We think it as a future

### Table 1

| Variables                     | Results                                      |
|------------------------------|----------------------------------------------|
| Gender (n)                   | Male 1                                       |
|                              | Female 6                                     |
| Age, years                   | 67 (53–85)                                   |
| Performance Status (n)       | 0                                            |
|                              | ≥1                                           |
| Smoking history              | 2                                            |
| Respiratory comorbidity (n)  | COPD 1                                       |
|                              | Asthma 1                                     |
| Spirometry test              | VC (L) 2.19 ± 0.50                           |
|                              | %VC 86.3 ± 10.8                              |
|                              | FEV1 (L) 1.62 ± 0.34                         |
|                              | FEV1/FVC 84.6 ± 9.2                          |

VC: vital capacity, FEV1: forced expiratory volume in 1 s, FVC: functional vital capacity.
In conclusion, we found CSS which is a complicated procedure that has few reports in the literature led to be acceptable result for early stage lung adenocarcinoma. In the right upper lobe, 3 subsegments resection was balanced to guarantee preservation of the residual lungs.

Conflicts of interest

Conflict of interest statement: the authors have no competing interests.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

[1] D.R. Aberle, A.M. Adams, C.D. Berg, W.C. Black, J.D. Clapp, R.M. Fagerstrom, et al., Reduced lung-cancer mortality with low-dose computed tomographic screening, N. Engl. J. Med. 365 (2011) 395–409.
[2] R.J. Ginsberg, L.V. Rubinstein, Randomized trial of lobectomy versus limited resection for T1 N0 non-small cell lung cancer. Lung Cancer Study group, Ann. Thorac. Surg. 60 (1995) 615–622.
[3] T. Koike, Y. Yamato, K. Yoshiya, T. Shimoyama, R. Suzuki, Intentional limited pulmonary resection for peripheral T1 N0 M0 small-sized lung cancer, J. Thorac. Cardiovasc. Surg. 125 (2003) 924–928.
[4] M. Okada, T. Koike, M. Higashiyama, Y. Yamato, K. Kodama, N. Tsubota, Radical sublobar resection for small-sized non-small cell lung cancer: a multicenter study, J. Thorac. Cardiovasc. Surg. 132 (2006) 769–775.
[5] H. Nomori, T. Mori, K. Ikeda, K. Yoshimoto, K. Iyama, M. Suzuki, Segmentectomy for selected cT1N0M0 non-small cell lung cancer: a prospective study at a single institute, J. Thorac. Cardiovasc. Surg. 132 (2006) 769–775.
[6] Rodney J. Landreneau, Daniel P. Normolle, Neil A. Christie, Omar Awais, Joseph J. Wizorek, Ghulam Abbas, et al., Recurrence and survival outcomes after anatomic segmentectomy versus lobectomy for clinical stage I non-small-cell lung cancer: a propensity-matched analysis, J. Clin. Oncol. 32 (2014) 2449–2455.
[7] W.D. Travis, E. Brambilla, A.G. Nicholson, Y. Yatabe, J.H.M. Austin, M.B. Beasley, et al., WHO Panel, The 2015 world health organization classification of lung tumors: impact of genetic, clinical and radiologic advances since the 2004 classification, J. Thorac. Oncol. 10 (2015) 1243–1260.
[8] M. Noguchi, A. Morikawa, M. Kawasaki, Y. Matsuno, T. Yamada, S. Hirohashi, et al., Small adenocarcinoma of the lung. Histologic characteristics and prognosis, Cancer 75 (1995) 2844–2852.
[9] Suzuki K, Watanabe S, Wakabayashi M, Moriya Y, Yoshino I, Tsuibo M, et al. A nonrandomized confirmatory phase III study of sublobar surgical resection for peripheral ground glass opacity dominant lung cancer defined with thoracic thin-section computed tomography (JCGO0804/WJOG4507L). DOI: 10.1200/JCO.2017.35.15_suppl.8561 J. Clin. Oncol. 35, no. 15_suppl (May 2017) 8561-8561.
[10] L. Fournel, R. Zaimi, M. Grigoriou, J.B. Stern, D. Gossot, Totally thoracoscopic major pulmonary resections: an analysis of perioperative complications, Ann. Thorac. Surg. 97 (2014) 319–342.

Table 2

| Case No. (age, sex) | B.I. | main location of tumor | Radiological size (cm) | Surgical approach | Resected location | Pathological diagnosis | Recurrence | Prognosis |
|--------------------|------|------------------------|-----------------------|-------------------|------------------|-----------------------|------------|-----------|
| 1 (67, F)          | 0    | S1a                    | 1.5                   | VATS              | S1a+S2a          | t1a-pIA1, pl0, G1, ly0, v0, adeno | No         | 72 mo, alive |
| 2 (71, F)          | 250  | S2a                    | 1.4                   | VATS              | S1a+S2a          | t1a-pIA1, pl0, G1, ly0, v0, adeno | No         | 60 mo, alive |
| 3 (53, F)          | 0    | S2b                    | 1.1                   | VATS              | S1a+S2a          | t1a-pIA1, pl0, G1, ly0, v0, adeno | No         | 28 mo, dead |
| 4 (64, F)          | 0    | S1a                    | 1.8                   | VATS              | S1a+S2a          | t1a-pIA1, pl0, G1, ly1, v0, adeno | No         | 26 mo, alive |
| 5 (85, M)          | 1800 | S2b                    | 1.9                   | VATS              | S2a+S3a          | t1a-pIA1, pl0, G1, ly0, v0, adeno | No         | 32 mo, alive |
| 6 (67, F)          | 0    | S2b                    | 1.3                   | VATS              | S2a+S3a          | t1a-pIA1, pl0, G1, ly0, v0, adeno | No         | 26 mo, alive |
| 7 (53, F)          | 0    | S1a                    | 1.2                   | VATS              | S2a+S3a          | t1a-pIA1, pl0, G1, ly0, v0, adeno | No         | 18 mo, alive |

VATS: video-assisted thoracoscopic surgery.

a Due to pneumonitis.