

# Lobectomy Versus Segmentectomy in Radiologically Pure Solid Small-Sized Non-Small Cell Lung Cancer

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**Background.** The indication for limited resection of radiologically pure solid non-small cell lung cancer (NSCLC) is controversial owing to its invasive pathologic characteristics. This study was performed to compare the outcomes after lobectomy and segmentectomy in these NSCLC patients.

**Methods.** We retrospectively reviewed 251 patients with radiologically pure solid cT1a N0 M0 NSCLC who underwent lobectomy or segmentectomy, and the preoperative characteristics of the patients treated with the two operative techniques were matched using propensity score methods. Overall survival (OS) and disease-free survival (DFS) curves were compared using the log rank test, and differences in survival were also evaluated by the McNemar test. The preoperative factors and surgical procedure were analyzed with the multivariate Cox proportional hazards regression model to identify independent predictors of poor OS and DFS.

**Results.** In the propensity score matched lobectomy and segmentectomy groups (87 patients per group), the 5-year and 10-year OS rates were 85% versus 84% and 66% versus 63%, respectively; and the 5-year and 10-year DFS rates were 80% versus 77% and 64% versus 58%, respectively. There were no significant differences between the two groups in OS or DFS by the log rank test, and also no significant differences in 3-year, 5-year, or 7-year OS or DFS by the McNemar test. Although age, smoking status, pulmonary function, and carcinoembryonic antigen were identified as significant predictors of both OS and DFS, the surgical procedure was not identified.

**Conclusions.** Similar oncologic outcomes after lobectomy and segmentectomy were indicated among patients with radiologically pure solid small-sized NSCLC.

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Since the Lung Cancer Study Group (LCSG) performed a prospective randomized study of limited resection versus lobectomy for non-small cell lung cancer (NSCLC) of 3 cm or less, and demonstrated that limited resection had a threefold higher locoregional recurrence rate [1], lobectomy has been the standard surgical procedure for NSCLC patients. However, enhancements in imaging technology have increased the detection of smaller nodules and ground-glass opacities (GGOs), and computed tomography (CT) screening initiatives have also helped to create a growing cohort of patients with smaller and more indolent tumors than those assessed by the LCSG [2].

The new classification for adenocarcinoma includes the introduction of two unique classifications: adenocarcinoma in situ and minimally invasive adenocarcinoma [3]. As they are considered indolent neoplasms rarely associated with nodal involvement [4], many studies of intentional limited resection addressed these adenocarcinomas, which are represented as pure ground-glass nodule (GGN) or part solid GGN on CT, and excellent surgical outcomes with no evidence of recurrence after limited resection were demonstrated [5, 6]. In contrast, radiologically pure solid tumors represent invasive pathologic characteristics, and poorer postoperative outcome was suggested when compared with tumors with a GGO component [7]. Therefore, the indication for limited resection for radiologically pure solid NSCLC is still controversial even though tumor size is small [7, 8].

In this study, we retrospectively reviewed radiologically pure solid small-sized NSCLC in patients who underwent lobectomy or segmentectomy and sought to investigate the oncologic outcomes between lobectomy and segmentectomy in propensity score-matched patients adjusted for preoperative factors.

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**Abbreviations and Acronyms**

CEA	=	carcinoembryonic antigen
CI	=	confidence interval
CT	=	computed tomography
DFS	=	disease-free survival
FEV <sub>1</sub>	=	forced expiratory volume in 1 second
FVC	=	forced vital capacity
GGN	=	ground-glass nodule
GGO	=	ground-glass opacity
HR	=	hazard ratio
LCSG	=	Lung Cancer Study Group
NSCLC	=	non-small cell lung cancer
OS	=	overall survival

**Patients and Methods**

This study was approved by the Institutional Review Boards of Niigata University Hospital and Niigata Cancer Center Hospital. As this was a retrospective study, the need to obtain written informed consent from each patient was waived.

In this study, we conducted a retrospective evaluation of cT1a N0 M0 NSCLC patients, according to the 7th edition of the TNM classification [9], with radiologically pure solid appearance who had undergone lobectomy or segmentectomy. The CT findings were reviewed by radiologists of each institution, and re-reviewed by the authors (T.K., T.K., and T.H.). The pure solid tumor was defined as a tumor without GGO component evaluated with the reconstructed thin-section helical CT scan, as described previously [8]. Patients with a tumor located within the inner half of the lung field on CT, pleural dissemination, positive pleural effusion, or lavage cytology, and intraoperatively identified positive lymph node were excluded. As for patients with adequate pulmonary function for lobectomy in whom intentional segmentectomy was planned, the surgical procedure was converted from segmentectomy to lobectomy when a positive lymph node was identified intraoperatively, and these patients were excluded from this study.

Between January 1998 and December 2009, a total of 251 patients fulfilled the inclusion criteria and were enrolled in this study. Of the 251 patients, 168 were male and 83 were female, and the median age was 68 years (range, 37–84; data not shown). Lobectomy was performed in 151 patients, and segmentectomy was performed in 100 patients (Table 1). Tumor histology was adenocarcinoma in 196 patients, squamous cell carcinoma in 42 patients, and other cell types in 13 patients.

All patients underwent preoperative staging with CT and pulmonary function testing. Additional diagnostic testing was performed at the discretion of the individual physician, according to the patient's symptoms and clinical findings. Positron emission tomography-CT was not used for preoperative staging in any of the patients nor were invasive modalities for mediastinal lymph node staging, such as mediastinoscopy or endobronchial ultrasound-guided transbronchial needle aspiration.

Segmentectomy was performed in the high-risk subgroup of patients with decreased pulmonary function or comorbid disease, such as underlying pulmonary or heart disease, and advanced age. In patients with cT1a disease with adequate pulmonary function for lobectomy, intentional segmentectomy was considered unless the tumor was located in the right middle lobe or the patient's consent was not obtained [10]. The surgical procedures were decided depending on the surgeons' or institutions' policies regarding these patients, and lobectomy was more likely to be selected for patients with preoperative tumor marker elevation. Among the 100 patients who underwent segmentectomy, the segmentectomy was intentionally performed in 74 patients and was performed in the high-risk subgroup of 26 patients (data not shown). Because our thoracoscopic surgery technique was an integrated surgical approach consisting of mini-thoracotomy with video monitoring and direct visualization, all surgical procedures were performed through conventional or small open thoracotomy approach. Systematic mediastinal lymphadenectomy was basically performed in patients who underwent lobectomy or intentional segmentectomy. To shorten the operating time, selective lymphadenectomy or lymph node sampling might have performed in the relatively high risk subgroup of patients for perioperative complications, such as advanced age. In some patients for whom intentional segmentectomy was selected, the N1 nodes were pathologically assessed intraoperatively. If negative, systematic mediastinal lymphadenectomy might be skipped; if positive, the surgical procedure was converted to lobectomy, and these patients were excluded from this study. Systematic mediastinal lymphadenectomy was performed in 121 of the 151 patients who underwent lobectomy, and in 44 of the 100 patients who underwent segmentectomy (Table 1).

Patients were seen approximately every 2 to 3 months after surgery in accordance with the clinical routines of each center. The follow-up evaluation included a physical examination, chest radiography, and measurement of tumor markers. A CT scan of the thorax with or without the abdomen was performed every 6 to 12 months. If a patient showed any symptoms or signs of recurrence, additional imaging was performed. Recurrence was defined as locoregional if it occurred within the same lobe, or in the ipsilateral thoracic cavity, and in hilum or mediastinal lymph nodes or both. Newly developed lung lesions were deemed recurrent unless they differed histologically or had a large GGO component on CT. Recurrence in the lung was scored as locoregional recurrence only when it developed in the same lobe.

**Statistical Analysis**

We used propensity score methods to control for potential differences in the baseline characteristics of patients treated with the two operative techniques, and patients who underwent segmentectomy were matched to patients who underwent lobectomy on the basis of the propensity score, as utilized previously [11]. We calculated propensity scores using a logistic regression model

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