Total thoracoscopic pulmonary segmentectomy


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Received 12 September 2008; received in revised form 25 February 2009; accepted 23 March 2009; Available online 12 May 2009

Abstract

Objective: In lung resection, thoracoscopy has been mainly used for wedge resection and lobectomy. There have been very few reports on pulmonary segmentectomy, mainly because of its complex nature. The present report evaluates the safety and efficacy of thoracoscopic pulmonary segmentectomy for the treatment of benign lung diseases or small lung carcinomas.

Methods: The study involved 30 patients who underwent thoracoscopic segmentectomy without a minithoracotomy from September 2004 to March 2008. The median age of the patients was 69 years (range, 16—81 years). Four 5—20 mm ports were used. The pulmonary vessels were ligated, and the bronchi were closed using a stapler. An electrocautery was used for intersegmental dissection. Chest tubes were inserted in all cases.

Results: Twenty-eight patients underwent complete thoracoscopic segmentectomy. A minithoracotomy was created in one case because of arterial bleeding, and open lobectomy was performed in another case owing to the diagnosis of small cell carcinoma. The operative time ranged from 147 to 425 min (median time, 216 min). The inserted chest tubes were maintained in position for 1—7 days (median duration, 1 day). One patient developed subcutaneous emphysema that spontaneously resolved. No mortality was observed for 30 days after the surgery. Further, no local recurrence or metastases were observed during follow-up in cases of malignancy.

Conclusions: Thoracoscopic pulmonary segmentectomy is a feasible and safe technique. Reduced postoperative pain and an improved cosmetic outcome are considered advantages of this minimally invasive procedure.

Keywords: Thoracoscopy; Segmentectomy; Benign lung disease; Lung cancer; Air-containing nodule

1. Introduction

Pulmonary segmentectomy is performed for patients with benign lesions such as those caused by infectious diseases, and for select patients with non-small cell lung carcinoma (NSCLC).

Owing to developments in computed tomography (CT) and the improved quality and resolution of scans thus obtained, lung cancers are increasingly being diagnosed at an early stage. Consequently, sublobar pulmonary resection is being indicated more frequently [1,2].

Some authors have described pulmonary segmentectomy performed under thoroscopic guidance and with direct vision through a small thoracotomy [3]. However, few reports have described complete thoracoscopic pulmonary segmentectomy [4,5]. This report describes a technique for thoracoscopic pulmonary segmentectomy and the early postoperative results obtained with this procedure.

2. Patients and methods

Our institutional ethics committee approved of this retrospective study, and the chairperson waived the need for obtaining the consent of individual patients. This study involved 30 consecutive patients who underwent complete thoracoscopic segmentectomy with written informed consent between September 2004 and March 2008. During preoperative investigations, 23 patients were diagnosed with lung tumors that were considered malignant but were not assessed pathologically; 3, with lung cancer of high-risk; 2, with solitary metastatic lung tumor; and 2, with benign lesions. Of the 23 patients with lung tumors, 18 had nonsolid nodules and 5 had solid nodules. The diameters of the nonsolid nodules, as determined from CT scans, were 2.5 and 2 cm or less in 2 and 16 cases, respectively, while the diameter of the solid nodules was less than 2 cm in all cases.

The median age of the patients was 69 years at the time of thoracoscopic resection (range, 16—81 years).

2.1. Thoracoscopic technique

The patients were placed in the lateral decubitus position, and the lung was isolated with a double-lumen endotracheal
tube. The operating room set-up was such that the surgeon stood near the patient’s anterior chest wall, facing a monitor. The assistant stood with his/her back toward the surgeon, facing a monitor. The first trocar was inserted along the midaxillary line, through the fourth intercostal space in the case of upper lobe lesions, and through the sixth intercostal space in the case of lower lobe lesions. An endoscopic rod-lens telescope (10 mm, 30°) was positioned at this port. Additionally, one 20 or 15 mm flexible trocar and two 5 mm trocars were inserted. First, the arterial branches were dissected, and the hilar lymph nodes were resected, frozen sectioned, and assessed in cases of lung cancer or suspected malignancy. Ligation was the preferred mode of vessel division, and the bronchus was mainly divided with a stapler. The parenchyma was dissected along the intersegmental pulmonary veins by using an electrocautery, and the venous branches running into the affected segment were divided. In anatomically complex cases, the intersegmental pulmonary veins and the venous branches were identified preoperatively, and individual operative dissections were simulated by performed contrast-enhanced CT with the three-dimensional volume-rendering method. Staplers were used in the peripheral lung. Since a sufficient margin, greater than the tumor diameter, was required, the resection line was designed on the segment adjacent to the affected one, or portions of a few adjacent segments or subsegments were extirpated.

In most cases, after division of the bronchus, the whole lung was expanded and then collapsed for visualization of the segmental inflation–deflation line. In some cases, only the affected segmental bronchus was selectively inflated by oxygen insufflation through the biopsy channel of the bronchofiberscope before bronchial division [6]. The resected segment was withdrawn through the 15 or 20 mm trocar incision. In lung cancer cases where an air-containing nodule larger than 2 cm was detected or the shadow of a solid tumor was observed on thin-section CT scans, mediastinal lymphadenectomy was performed. A chest tube was inserted through the trocar site and maintained there.

3. Results

The characteristics of the patients are listed in Table 1. The study involved 12 men and 18 women with a median age of 67 years (range, 16–81 years). Of these, 23 patients had lung cancer; 2, metastatic disease; and 5, benign diseases. Twenty-eight patients underwent complete thoracoscopic pulmonary segmentectomy. In one case, a mini-thoracotomy (12 cm) was created because of arterial bleeding that resulted in a blood loss of 280 ml. In another case, open lobectomy was performed because of a frozen rapid diagnosis of small cell carcinoma. In this case, a segmentectomy was performed with an R0 surgical margin (1.5 cm), but the procedure was eventually revised to an open lobectomy since a wider margin could be maintained and a lymphadenectomy could be performed. Of the 18 preoperatively undiagnosed nonsolid tumors, 16 were subsequently diagnosed as bronchioloalveolar carcinomas and 2 as benign lesions. Of the five preoperatively undiagnosed solid tumors, two were subsequently diagnosed as squamous cell carcinomas, one as an adenocarcinoma, one as a small cell carcinoma (where the operative procedure was revised to an open lobectomy), and one anthracotic nodule by analysis of rapid frozen sections. Pathologic examination revealed that curative resections were achieved with tumor-free surgical margins in all patients with malignancy.

The locations of resected segments are shown in Table 2. In the case of the 28 patients who underwent complete thoracoscopic pulmonary segmentectomy, the median operative time was 216 min (range, 147–425 min) and the median blood loss, 100 ml (range, 3–305 ml). No patient required
blood transfusion. The inserted chest tubes were maintained in position for 1—7 days (median duration, 1 day) after the procedure (Table 3).

Twenty patients with lung cancer and three with benign lesions, including capillary hemangioma, antrhacotic nodule, and inflammatory nodule, were diagnosed postoperatively.

No hilar lymph node involvement was observed in cases of malignancy. In all the lung cancer cases, tumors were pathologically graded as T1N0M0. No tumor recurrence was noted during the follow-up in cases of malignancy, and the survival rate among our patients who underwent segmentectomies was found to be 100%.

4. Discussion

Pulmonary function is largely preserved after segmentectomy in which a small section of the lung is resected. A recent study has highlighted the benefits of thoracoscopic surgery in terms of morbidity, pain control, duration of hospitalization, and the cosmetic outcome [7—9]. Thus, thoracoscopic segmentectomy may be recognized as the ideal minimally invasive surgery for pulmonary resection. Although there have been many reports on thoracoscopic lobectomy and partial resection, few have described thoracoscopic segmentectomy [4,10]; this is mainly because of the complexity of the latter procedure and the possibility of air leakage from the parenchyma. Thoracoscopic segmentectomy poses some unique challenges to surgeons.

The first challenge is the approach to be adopted for thoracoscopic division of the parenchyma. Visualization of an intersegmental plane by creating an inflation-deflation line enables dissection along the anatomical plane. The procedure adopted is typically as follows. The segmental bronchus is ligated with ventilation of the contralateral lung followed by both lungs. Thereafter, single-lung ventilation is resumed, and the diseased segment remains inflated by collateral ventilation through Kohn’s pores, while the other segments collapse. A recent study has indicated the effectiveness of selective jet ventilation for visualizing an intersegmental plane [6]. This technique may also afford a good surgical view with sufficient working space.

Another challenge related to thoracoscopic segmentectomy is obtaining an adequate anatomical interpretation of respective cases for dissecting the parenchyma. In previous studies on thoracoscopic segmentectomy, the procedure was considered successful only if segments could be resected by a relatively simple surgical technique [4,5,10]. In this regard, our study is unique because surgical resection was performed even for segments that were technically difficult to resect. The operative time was longer in the case of some patients because of complexities in their anatomy, such as the presence of lateral or posterior basal segments. Nevertheless, the operative time was relatively short (147—210 min) in the case of a simple segmentectomy performed, for example, on the lingual segment or superior segment in the lower lobe.

It is ideal if all segments can be resected by an anatomically similar approach. In the present study, surgically complex resection was achieved with preoperative or intraoperative simulation of the pulmonary vessels by three-dimensional volume-rendering imaging performed using multidetector-row CT [11—13].

The third challenge associated with thoracoscopic segmentectomy is that the indication of sublobar resection for lung cancer is controversial. Surgical resection accompanied by dissection of the hilar and mediastinal lymph nodes is the accepted treatment for patients with NSCLC, and more extensive resection or complete lobar resection is recommended in cases with a risk of locoregional recurrence [14]. Recently, some studies have reported that the risk of local recurrence is not high in select NSCLC patients with small tumors [1,15—18].

In the present study, we selected patients who were deemed to have noninvasive tumors because the tumor shadows on CT images had the appearance of air-containing nodules or because the nodule diameter was 2 cm or less in the case of squamous cell carcinoma of the peripheral lung [2,19,20]. Although our data are rather preliminary because of the short follow-up period, no tumor recurrence was noted even in the case of high-risk patients who underwent segmentectomy.

Although bronchofiberoptic or percutaneous needle biopsy was performed in some cases, an accurate diagnosis could not be established. In our opinion, excision should be performed in cases where radiological findings indicate malignancy. In cases where the lesion is an air-containing nodule we recommend that a short follow-up period be maintained. In the present study, we performed follow-up thoracic CT after 3—6 months. If pulmonary lesions were still observed at this time, surgical resection or further follow-up was proposed. Wedge lung resection with sufficient margin was performed for small air-containing nodules located near the visceral pleura. Thoracoscopic segmentectomy was adopted for those located in the deep parenchyma.

Although our experience with thoracoscopic segmentectomy is limited, we consider this technique to be feasible and safe. The cosmetic outcome is favorable owing to the small size of the resected specimen. Moreover, similar to open segmentectomy, thoracoscopy offers the advantages of reduced postoperative pain and preservation of pulmonary function.

References


Appendix A. Conference discussion

Dr D. Grunenwald (Paris, France): I think one thing is the disadvantage of extracting the specimen through a trocar. Without a utility thoracotomy you are extracting your specimen and there is some damage on the specimen for the pathologist in terms of examining margins, et cetera.

Dr Oizumi: Maybe you are right, but most of the cases of our study include GGO, so it’s smooth to extract for it’s sponge like feature. First we enlarge the inside, the intercostal muscle, it’s about 3 or 4 cm, and the specimen is lifted into the bag. It is first retracted to the extrathoracic space between the muscle and the chest wall. Next we retrieve it from the small wound. The assistant squeezes the bag.

Dr Grunenwald: Without exploding the bag?

Dr Oizumi: No. In Japan we have very strong bags.

Dr E. Canalis (Barcelona, Spain): In the last years we have seen the paradigm or more universally accepted operation for breast cancer change from large operations to small resections, but with the condition of having chemo and radiotherapy and also hormone therapy. Do you think we are taking steps to go to a change in the paradigm of operation for lung cancer in stage I, for example? What would be the conditions to universally accept these segmental or atypical resections?

Dr Oizumi: I didn’t follow your question precisely.

Dr Grunenwald: He said you are changing the paradigm of treating lung cancer by doing very small surgery. I think that Japanese surgeons are used to doing very large, extended surgery, including superior vena cava, left atrium, et cetera, and now you are doing very small, small surgery on small nodules.

Dr Oizumi: We do this procedure only in the GGO cases of small nodules. VATS lobectomy, thoracoscopic lobectomy was applied in solid cases in our institution, solid cases in which the diameter is more than 2 cm. For T2 tumor we do an open thoracotomy with a posterolateral incision to educate the trainee.