Lung resection for bronchogenic carcinoma after pneumonectomy: a safe and worthwhile procedure

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Abstract

Objectives: Patients treated surgically for lung cancer can develop either a metachronous cancer or a recurrence. The appearance of a new cancer on the remaining lung after a pneumonectomy poses unique treatment problems, and surgery is often considered contraindicated. We report on the outcome of resections for lung cancer after pneumonectomy performed for lung cancer.

Methods: We reviewed the records of patients who underwent a resection of bronchogenic carcinoma on the remaining lung from 1990 to 2002.

Results: There were 14 patients (13 males and 1 female) with a median age of 64 years (range 51–74). Median preoperative Fev1 was 1.45 (range 1.35–2.23), corresponding to 59% of predicted Fev1 (range 46–80%). Resection was performed between 11 and 264 months after pneumonectomy (median 35.5). The resections performed were: one wedge resection in 11 patients, two wedge resections in two patients and two segmentectomies in two other patients; one patient underwent a third resection. Diagnosis was metachronous cancer in 12 patients and metastasis in two patients. Complications occurred in three patients (21%), while operative mortality was nil. Mean hospital stay was 10.5 days (6–25). Two patients received chemotherapy (one after local recurrence, one after the third resection). Overall 1, 3 and 5 year survivals were 57, 46 and 30%, respectively (median 21 months). For patients with a metachronous cancer they were 69, 55 and 37% (median 57 months), while neither patient with a metastatic tumor survived 1 year (P = 0.03).

Conclusions: Limited lung resection on a single lung is a safe procedure associated with acceptable morbidity and mortality rates. In patients with a metachronous lung cancer, long-term survival with a good quality of life can be obtained with limited resection on the residual lung.

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Keywords: Single lung surgery; Pneumonectomy; Metachronous lung cancer

1. Introduction

Surgical resection for lung cancer on a single lung after pneumonectomy for a previous lung cancer is an uncommon operation; according to Donington [1], fewer than 100 cases have been reported in the literature. Although it is true that lung resection on a single remaining lung is often contraindicated by functional status or by the presence of distant metastasis, it must be supposed that even patients with an adequate functional reserve and no metastasis are often not referred to the thoracic surgeon for resection, given the large total number of patients operated on for lung cancer and the number of those who have undergone a pneumonectomy.

The misconception by many physicians that an operation on a single lung cannot be performed might be depriving patients of a potentially life saving therapeutic option. We present the results of surgery performed on a single lung in a group of 14 patients who previously had a pneumonectomy for lung cancer.

2. Material and methods

From 1990 to 2002, 14 patients who had had a pneumonectomy (six right and eight left) for lung cancer underwent resection for a new cancer on the remaining lung. There were 13 males and one female; median age was 64 years (range 51–74). The first resection was a lobectomy in a patient who later underwent a completion pneumonectomy. Extended pneumonectomy was performed in three cases; in one case pneumonectomy was associated with left
atrial resection, in another with carinal resection and in the last with carinal resection and SVC resection. The records of these patients were analyzed. The new tumors were classified according to Martini and Melamed [2] as either metachronous lung cancer or metastatic lung cancer. The disease was staged according to the revised TNM staging system [3]. The cumulative survival rate was estimated by the Kaplan–Meier method and the log-rank test was used to compare survival curves.

The significance threshold was set at \( P < 0.05 \). The date of pulmonary resection after pneumonectomy was considered the starting point and the date of death or last contact as the end point; patients who died for causes not related to lung cancer were considered censored [4].

3. Results

The histology at pneumonectomy was epidermoid carcinoma in 11 patients and adenocarcinoma in three patients; the stage of the disease according to the revised TNM staging system [3] was: IA in two patients, IB in three patients, IIB in five patients (2 T3N0 and 3 T2N1 disease), IIIA in one patient (T3N2) and IIIB in three patients (1T4N0, 1 T4N1 and 1 T4N2 disease); the two patients with N2 disease underwent adjuvant radiation therapy. All but one patient who had persistent cough were asymptomatic at the time of detection of the contralateral tumor. The new tumor was detected in all cases by chest X-ray; bronchoscopy was performed in all patients but was diagnostic in only two cases. In all the other cases the diagnosis of cancer was suspected but not certain before resection; we did not use transthoracic fine needle aspiration to determine the nature of the tumor in this group of patients. After a metastatic work-up that excluded distant metastases and mediastinal adenopathy (lymph nodes more than 1 cm in diameter) patients were functionally evaluated with standard pulmonary function tests (PFT) and a stair climbing test to estimate oxygen consumption [5,6]; and only one patient had an effort oxygen consumption test. Median Fev1 was 1.451 (range 1.35–2.23) corresponding to 59% of predicted Fev1 (range 46–80%). Diffusion capacity for carbon monoxide was obtained in only five cases, and was in all cases higher than 45%. Oxygen consumption estimated by a stair climbing test was equal to or higher than 15 ml/kg per min in all patients, and VO₂ max was 17.1 ml/kg per min in only those patients who had this test. Arterial blood gas at rest was normal in all patients. All patients had a predicted popFev1 of more than 30%.

Resection on the single lung was performed after a median of 35.5 months (range 11–264) through an antero-lateral thoracotomy in 10 cases, a median sternotomy in three cases (in one of these followed after 19 months by a lateral thoracotomy for a third resection) and a total muscle-sparing thoracotomy in one case. Ten patients had a single wedge resection, two patients had a double wedge resection and two patients a segmental resection, while the patient who had a third resection had a single wedge again.

In three patients, at the beginning of our experience, we used a veno-arterial by-pass with a pump oxygenator connected to the patient through femoral vessels to work on a collapsed lung; in one patient we used high frequency jet ventilation, while in the others frequent periods of apnea after hyperoxygenation allowed deeper wedge resection, segmental resection and lymph node sampling.

Out of 14 patients, 12 had a metachronous lung cancer, and two patients had a metastatic cancer; histology was epidermoid carcinoma in seven cases, adenocarcinoma in six cases and large cell carcinoma in one case. The patient who had a third resection had a metachronous lung cancer at first and a metastatic cancer later. In all patients only lymph node sampling was obtained. The stage of the disease was IA in nine cases, IB in one case, IIIA (T1N2) in one case, IIIB (T4 multiple nodules same lobe N0) in two cases, IV in one case (T1NOM1 2 nodules in different lobes). The patient who had the third resection was in stage IA at first and IV later (M1 brain treated by radio surgery). Operative mortality was nil and all patients were extubated at the end of the operation. Complications occurred in three patients (21%) and were sputum retention requiring a temporary tracheostomy, atelectasis, and atrial fibrillation (Table 1). Mean hospital stay was 10.5 days (6–25) and no patient was discharged with supplementary oxygen. Two patients received chemotherapy, one after local recurrence and one after the third resection and after brain radio-surgery.

Follow-up was complete in all patients and ranged from 7 to 142 months (median follow-up: 11.5 months). Currently six patients are alive while one died from cardiac disease and the others from distant or local recurrences. The overall 1, 3 and 5 year survival rates were 60, 50 and 37% with a median survival of 21 months (Fig. 1). For metachronous lung cancer 1, 3 and 5 year survival rates were 71, 59 and 45%, respectively, with a median survival of 48 months; no patient with a metastasis survived longer than 1 year \( (P = 0.03) \) (Fig. 2).

After returning home all patients were able to resume their daily activities.

4. Discussion

The possibility of a new lung cancer or a recurrence after complete resection of a bronchogenic carcinoma is well recognized [7–10] but lung resection on a single lung after pneumonectomy is rarely reported, and it might be supposed that some patients do not undergo a further and possibly curative resection in the belief that it is contraindicated. In carefully selected patients, however, long-term survival can be achieved and operative mortality may be very low.
Preoperative oncological evaluation of a new lesion suggestive of lung cancer involves the same tests as diagnosis of the initial cancer; however, in our series two patients without mediastinal adenopathy (lymph nodes more than 1 cm in diameter) resulted having an N2 disease; a PET scanning of mediastinum (if readily accessible) should be obtained in this group of patients and might be a good alternative to routine mediastinoscopy. Functional evaluation includes standard PFT and may include more sophisticated tests like the effort oxygen consumption test. Median Fev1 in our patients was 1.45 l, corresponding to a median of 59% of predicted Fev1, a value that allows for wedge or segmental resection. In our patients we performed a stair climbing test and calculated oxygen consumption according to the formula proposed by Gupta [5]; alternatively, a 6-min walking test (6MWT) can be used to evaluate cardio-pulmonary reserve. A 6MWT of less than 2000 ft (roughly 600 m) correlates with a VO2 max of less than 15 ml/kg per min [14]. We do not think that oxygen consumption test is mandatory before performing a limited resection in a single lung patient, as Westermann [12] maintains.

Major resections like lobectomy may cause concern in this kind of patient and even though they are occasionally reported [15], they are probably contraindicated in most cases due to the high mortality rate [16], except perhaps for a middle lobectomy as shown by Massard [17].

We used different surgical approaches, mostly an anterolateral thoracotomy but also a median sternotomy for those patients in whom the tumor had switched into a retrosternal position by transmediastinal herniation after pneumonectomy [17].

Femoro-femoral cardiopulmonary bypass (CPB) was used in three cases at the beginning of our experience (two wedge resections, one segmentectomy of the anterior segment of the right upper lobe) to work on a deflated lung, but although its use was not associated with complications, we realized it was not mandatory and we do not recommend its use as a routine procedure. Along with other authors [18], we believe that CPB might be of help in performing segmentectomy as it allows less manipulation and contusion of the inflated lung. However, the decision, whether to use CPB or not must be taken on a case-by-case basis.

The long-term survival rate was better for metachronous than for metastatic cancer in our series and in the experience of other groups also [1]. However, before denying a resection on the belief to face a metastasis, one should

**Table 1**

**Clinical data of the patients**

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a. alive; L, local; D, distant; AMI, acute myocardial infarction; Un, uneventful; S.ret, sputum retention; Af, atrial fibrillation; Atel, atelectasis; Bp, Bypass; Al, antero-lateral thoracotomy; Mst, median sternotomy; Tmst, total muscle sparing thoracotomy.

b. Stage IIIB for two nodules in the same lobe and stage IV for two nodules in different lobes.

c. This patient underwent a third resection 19 months later through a muscle sparing lateral thoracotomy after the treatment of a single brain metastasis by radio-surgery.

d. This patient was considered censored (see text).
consider that in most cases the histology of the new lesion cannot be determined before resection, and if the diagnosis of metastasis cannot be established preoperatively surgical resection is warranted.

Most of the resections we performed were wedge resections, which are usually considered inappropriate procedures for lung cancer [19,20]. Since all the long-term survivors in our series had this kind of resection, we agree with Donington that in these high risk patients, limited resection provides the best risk–benefit ratio.

In conclusion, limited lung resection for lung cancer on a single remaining lung is a worthwhile procedure in appropriately selected patients since it carries a low operative risk and allows for long-term survival with good quality of life. When a diagnosis of metastasis can be made preoperatively, surgery is an option but other treatment modalities may be warranted, given the poorer results compared to metachronous lung cancer.

References


Appendix A. Conference discussion

Dr P. De Leyn (Leuven, Belgium): We have the same experience, but in these patients it’s mostly not the pulmonary function and the gas exchange that is the problem, but it’s mostly the reduced pulmonary vascular bed with pulmonary hypertension. Did you look for these things in these patients when selecting them?

Dr Terzi: To evaluate the pulmonary hypertension?

Dr De Leyn: Yes, with echocardiography and…

Dr Terzi: No, we didn’t perform it. We used the exercise test, and when the exercise test result is good, with desaturation no more than 4%, tachycardia is in the normal range, we don’t think it is really necessary to perform echocardiography. However, maybe you are right, may be we should.

Dr T. Horvat (Bucharest, Romania): During these last 3 years, I did 6 procedures on the single lung, and these procedures, 5 were in the classic manner and 1 through thoracoscopy. Four were with malignant lesions. I couldn’t say that was a primary tumor. I considered it to be a metastasis. I want to ask you what criteria you have used to classify this lesion, the second lesion, like a primary tumor of the lung?

Dr Terzi: We used the well-known criteria of Martini and Melamed. Obviously you are not sure there is a new tumor if there is the same histology, but the criteria proposed by Martini can be useful to distinguish a metachronous from a metastatic tumor.

Dr Horvat: I read that you had 2 patients with 2 tumors and 2 wedge resections. The same patient with 2 tumors?

Dr Terzi: Yes, you are right, but the time since the first resection was more than 2 years, and the first resection was an N0 resection, so we considered 2 lesions to be 2 new tumors because there is the possibility of multifocality of lung tumor.

Dr Horvat: Also, about the metachronous definition, you are sure that all these cases were metachronous lesions, not synchronous, from a chronologic point of view?

Dr Terzi: We are confident that they were metachronous.

Dr Horvat: You are sure?

Dr Terzi: I am not sure. I am confident.

Dr F. Venuta (Rome, Italy): This series must be part of a larger series of patients, and you certainly turned down some of the patients that you have seen. Could you give us some insight about the reasons why other patients have been turned down from a second surgical approach?

Dr Terzi: I don’t have the exact figure of how many patients were turned down. The reason in most cases is a functional reason, if the patient has no metastasis.