Original Article

Salvage pneumonectomy for cancer in adult patients younger than 30 years: a case series

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Background: Many data are available on pneumonectomy for cancer in adults and for non-oncologic diseases in patients younger than 10 years, whereas few reports have addressed pneumonectomy for cancer in adult patients younger than 30 years. Given the increased number of younger patients diagnosed nowadays with pulmonary neoplasms and the need of salvage surgery after modern inductions or definitive treatments, it is worth to know the impact of salvage pneumonectomy in patients younger than 30 years.

Methods: From 1998 to 2018, 943 pneumonectomies for cancer were performed at our department, including 14 in adult patients younger than 30 years. All patients but two had previously undergone medical, radiotherapic or surgical treatments without any effective clinical impact. Age, gender, smoking habits, type, side and extent of surgical resection, oncologic history, pathological findings, post-operative course, 30-day or in-hospital morbidity and mortality rates and long-term follow-up were retrospectively collected.

Results: Eight patients were female; median age was 26 years. Two out of 14 patients had primary non-small cell lung cancers, 1/14 pulmonary atypical carcinoid, 6/14 pulmonary metastases, 2/14 synovial sarcoma, 1/14 Hodgkin lymphoma, 1/14 thymoma and 1/14 desmoid tumor. 6/14 patients had postoperative complications: 3/6 had hemothorax requiring re-do surgical exploration; 1/6 had early bronchopleural fistula; 1/6 had monolateral vocal cord palsy; 2/6 patient developed acute respiratory distress syndrome and subsequently died on 17th postoperative day.

Conclusions: Postoperative morbidity is not negligible and salvage pneumonectomy for cancer in patients younger than 30 years should therefore be considered only in case all the available therapeutic options have failed.

Keywords: Salvage surgery; pneumonectomy; younger patients; cancer; case series

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Introduction

Pneumonectomy is a high-risk surgical procedure accounting for fewer than 15% of all pulmonary resections performed for neoplasms. Although expected perioperative mortality is usually reported to range between 5% and 8%, a more recent literature analysis showed an overall 30-day mortality rate of 16–20%. Moreover, a six-month mortality rate of up to 25% has been reported in some series (1). When other anatomical structures close to the lung are locally involved, a radical procedure may be required to extend the volume of the entire resection to the closer infiltrated structures. In this case, extended pneumonectomy is defined as the removal of the whole lung associated with one or more of the following structures: tracheal carina, superior vena cava, aorta, left atrium, chest wall, and diaphragm (2).

Among all anatomic resections, pneumonectomy is associated with the highest postoperative mortality rate—in particular after preoperative treatments—and is often considered a cause of illness in itself, because of its adverse impact on patients' long-term quality of life. For these reasons, the indication for pneumonectomy should be always carefully evaluated, especially in very young patients. While young patients are better able to cope with the cardiopulmonary impact of resection, they are more prone to experience the entire spectrum of long-term quality of life impairment due to pneumonectomy itself.

Salvage surgery has been defined as surgical resection of persistent or recurrent tumors after previous local treatments with curative intent or exclusive chemo-radiotherapy in the case of bulky tumors originally considered ineligible for surgery (3,4). It should therefore be considered a last attempt to offer the patient a curative treatment for a disease no longer amenable to other therapeutic approaches.

Anecdotal cases of pneumonectomy in young patients have been reported, very often performed for rare tumors (5,6). On the other hand, given the increased number of younger patients diagnosed nowadays with pulmonary neoplasms and the need of salvage surgery after modern inductions or definitive treatments, it is worth to know the impact of salvage pneumonectomy in patients younger than 30 years.

We present the following article in accordance with the AME Case Series reporting checklist (available at https://jxym.amegroups.com/article/view/10.21037/jxym-21-47/rc).

Methods

This is an observational retrospective study. Data were collected consecutively and entered into our institutional general thoracic database at the point of care and reviewed and double-checked retrospectively. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Due to the retrospective nature of the study, the ethical committee approval was waived.

From 1998 to 2018, 943 pneumonectomies for cancer were performed at our department, including 14 (1.4%) in adult patients younger than 30 years. Written informed consent to undergo the procedure and the use of clinical and imaging data for scientific or educational purposes, or both, were obtained from all patients before the operation.

Age, gender, smoking habits, type, side and extent of surgical resection, oncologic history, pathological findings, postoperative course, 30-day or in-hospital morbidity and mortality rates and long-term follow-up data were collected by out-patient or phone check.

Postoperative death was defined as 30-day mortality or longer if mortality occurred during hospitalization. Complications were classified according to the Thoracic Morbidity and Mortality classification system (7) as minor (grade I and II) and major (grade IIIa, grade IIIb; grade IVa, grade IVb; grade V).

Operability was assessed by standard clinical and radiographic tests [whole-body computed tomography (CT scan)], nuclear imaging [whole-body 18F-fluorodeoxyglucose (FDG)-positron emission tomography (PET scan)] and staging procedures including bronchoscopy, endobronchial ultrasound, as appropriate. Preoperative pulmonary and respiratory function was assessed routinely by blood gas analysis, spirometry and lung perfusion scanning to identify the functionally prevalent lung; preoperative cardiac function evaluation was routinely performed by echocardiography with left ejection fraction and pulmonary artery pressure estimate and tread-mill stress test. Occasionally, the cardiopulmonary stress test was required for borderline patients to assess oxygen consumption. Postoperatively, patients received two assisted sessions of chest physiotherapy daily, starting on the first postoperative day, and were asked to repeat the physiotherapy program six times during the day until discharge (7-9).

Statistical analysis

Patient characteristics were summarized and tabulated

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Table 1 Patient's characteristics

Variables	Value (N=14)
Continues variables, median (IQR)	
Age, at surgery (years)	26.0 (19.0–30.0)
Months from diagnosis to surgery	12.0 (3.6–35.5)
FEV1, %	72.0 (59.9–89.7)
FEV1 (liters)	2.7 (2.1–2.8)
DLCO VA	82.4 (75.5–85.3)
Duration of surgery (min)	245 (210–305)
Length of stay (days)	8 (7–12)
Length of follow-up, median (years)	10.3
Categorical variables, n (%)	
Surgery side	
Right	9 (64.3)
Left	5 (35.7)
Female sex	8 (57.1)
Stage	
pN0	8 (57.1)
pN1	1 (7.1)
pN2	4 (28.6)
missing	1 (7.1)
Pre-treatments, yes	12 (85.7)
Post-surgery complications	6 (42.9)

IQR, inter quartile range; FEV1, forced expiratory volume in 1 second; DLCO, diffusing lung capacity for carbon monoxide; VA, alveolar volume.

using either counts and percent or median and interquartile range for categorical and continuous variables respectively. Overall survival (OS) was defined as the time from surgery or diagnosis to death. Patients alive at the last follow-up date were considered censored.

Results

Eight patients were two female and six males; median age was 26 (19.0–30.0). Nine pneumonectomies were performed on the right side; all the procedures were performed on the non-predominant lung with median perfusion of the resected lung of 17.4% (4.6–48.4%). Median preoperative forced expiratory volume in 1 s (FEV1) was 2.7 liters (2.1–2.8) and 72.0% (59.9–89.7%) of theoretical value; mean pre-operative percentage of theoretical value of carbon monoxide lung diffusion capacity related to alveolar volume (DLCO/VA) was 82.4% (75.5–85.3%).

Two patients had primary non-small cell lung cancers, one pulmonary atypical carcinoid, six pulmonary metastases, two synovial sarcoma, one Hodgkin lymphoma, one thymoma and one desmoid tumor.

All patients but two (atypical carcinoid and desmoid tumor) had previously undergone one or more lines of chemotherapy while six patients had also had ipsilateral lung resection; one patient with atypical carcinoid had been previously submitted to local treatment by rigid bronchoscopy at another hospital with radical intent (*Tables 1*,*2*).

Surgical approach was hemiclamshell in six cases, posterolateral thoracotomy in three cases and lateral muscle–sparing thoracotomy in five cases; standard pneumonectomy was performed in 7 patients; completion pneumonectomy was performed in 3 patients; extrapleural pneumonectomy was performed in 4 patients; all patients but two required intrapericardial dissection and vessel isolation. Median operative time was 245 min (210–305 min) seven patients were admitted to the intensive care unit after surgery while the others were transferred directly to the ward after the procedure. Six patients had postoperative complications: three had hemothorax requiring re-do surgical exploration; one had early bronchopleural fistula; one suffered from monolateral vocal cord palsy; one patient developed acute respiratory distress syndrome and subsequently died on 17th postoperative day. Median total length of stay was 8 days (7–12 days); one patient received postoperative combined chemo-radiotherapy and three patients adjuvant radiotherapy. Median OS was 26.8 months from surgery and 73.6 months from diagnosis.

Discussion

Indications for extended salvage procedures—defined as surgical rescue treatments after the failure of a wide spectrum of non-surgical options—can be considered in fit and young patients as the last curative attempt.

Although primary lung cancers are uncommon under 40 years and almost anecdotal under 30 years, metastatic lung involvement in very young patients is a complex clinical situation that thoracic surgeons have to face, in particular in high volume referral cancer centers. In some cases, pneumonectomy may offer the chance to resect

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Table 2 Clinicopathologic and surgical features of patients

N.	Sex	Age, years	Histology	Nodal status	Preoperative/ postoperative treatments	Operation	Complication	30-day mortality	Follow-up (months)	Status
1	M	27	Primary lung cancer (acinic cells)	pN2	Yes/no	Standard pneumonectomy	No	No	25.10	NED
2	F	30	Pulmonary metastasis from neural sheath tumor	pN0	Yes/no	Completion pneumonectomy	Bronchopleural fistula	No	4.73	DOD
3	F	21	Sinovial sarcoma	pN0	Yes/yes	Completion pneumonectomy	No	No	15.60	DOD
4	F	25	Primary lung cancer (adenocarcinoma)	pN2	Yes/no	Standard pneumonectomy	ARDS	Yes		
5	F	17	Pulmonary metastasis from teratoma	pN0	Yes/no	Standard pneumonectomy	No	No	125.90	NED
6	F	30	Primary lung cancer (carcinoid)	pN0	No/no	Standard pneumonectomy	Hemothorax	No	112.70	NED
7	F	30	Hodgkin Lymphoma	NA	Yes/no	Standard pneumonectomy	No	No	20.13	DOD
8	M	19	Pulmonary metastasis from osteosarcoma	pN0	Yes/no	Completion pneumonectomy	No	No	11.27	DOD
9	F	28	Pulmonary metastasis from squamous cells tumor of the breast	pN0	Yes/no	Standard pneumonectomy	No	No	145.43	NED
10	M	30	Sinovial sarcoma	pN0	Yes/yes	Standard pneumonectomy	Hemothorax	No	26.83	DOD
11	M	27	Thymoma	pN1	Yes/yes	Extrapleural pneumonectomy	No	No	183.43	NED
12	M	18	Desmoid tumor	pN0	No/no	Extrapleural pneumonectomy	Vocal cord palsy	No	127.20	NED
13	F	18	Pulmonary metastasis from osteosarcoma	pN2	Yes/yes	Extrapleural pneumonectomy	No	No	2.03	DOD
14	M	21	Pulmonary metastasis from osteosarcoma	pN2	Yes/no	Extrapleural pneumonectomy	Hemothorax	No	2.80	NED

NED, non evident disease; DOD, dead of disease; ARDS, acute distress respiratory syndrome.

residual disease not amenable to further treatments. More than 35 years ago the Lung Cancer Study Group stated that mortality after pneumonectomy should be less than 8% to comply with modern standards (10). More recently, lower rates have been reported (11,12), showing pneumonectomy is an acceptable procedure, in particular in salvage settings in young and fit patients.

Several series of pneumonectomies in children have been reported, where pneumonectomy was mainly performed for non-oncologic reasons in patients younger than 10 years (13-16). While much is known about pneumonectomy for cancer in adult patients (17,18), few data are available on the technical, pathophysiologic and clinical aspects of pneumonectomy performed for oncologic indications in adult patients younger than 30 years.

Our experience shows that salvage pneumonectomy in this cohort of patients is a time-consuming procedure with a significant postoperative surgical morbidity rate (28.5% of patients needed re-do surgery). On the contrary, total length of stay, ICU admission and postoperative mortality

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rates were not significantly higher than those reported after standard pneumonectomy. Moreover, two-year and five-year OS rates were 54% and 45% respectively, representing an encouraging result, in particular in the setting of a salvage procedure offered to patients who have already exhausted all the available therapeutic options.

Interestingly, the longer the interval between the first diagnosis of cancer and the salvage pneumonectomy is, the higher the OS. This can probably be explained by the fact that a more indolent tumor, treated my multiple lines of different therapeutic approaches, can maximally benefit from a salvage procedure compared to fast growing tumors ineffectively treated by other approaches and thus rapidly requiring a salvage treatment. This is the case of patients in our series requiring extrapleural pneumonectomy. On the one hand, they had indolent tumors (one desmoid tumor and one thymoma) and on the other, a metastatic osteosarcoma responding to multiple lines of chemotherapy before receiving a salvage surgical approach.

With regard to the patient presenting with Hodgkin lymphoma, pneumonectomy was performed in 2006 after six cycles of an ABVD (adriamycin, bleomycin, vinblastine and dacarbazine) scheme, then DHAP (dexamethasone, ara-c-cytarabine, cisplatin) for two cycles and BEACOPP (bleomycin, etoposide, adriamycin, cyclophosphamide, oncovin, procarbazine and prednisone) for another two cycles, without any sign of response and progressive disease with complete mediastinal and left lung involvement.

The recent development of molecularly targeted drugs and immunotherapy for both primary lung cancers and metastatic tumors will surely offer the chance of further effective treatments, but a longer observation period is needed to establish if this will definitively avoid rescue surgery or simply result in a different salvage approach, thus making this option even more challenging and rare (19-21).

Conclusions

The retrospective and mono-institutional nature of our study, the small number of patients and the oncologic heterogeneity of the study population are limitations that must be taken into consideration when analyzing the conclusions of our experience. Nonetheless, although postoperative morbidity is not negligible, salvage pneumonectomy for cancer in patients younger than 30 years can be considered a further treatment for patients who have already exhausted all the available therapeutic options.

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Footnote

Reporting Checklist: The authors have completed the AME Case Series reporting checklist. Available at https://jxym.amegroups.com/article/view/10.21037/jxym-21-47/rc

Data Sharing Statement: Available at https://jxym.amegroups.com/article/view/10.21037/jxym-21-47/dss

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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. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Due to the retrospective nature of the study, the ethical committee approval was waived. Informed consent was taken from all the patients.

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