



Total or partial vertebrectomy for lung cancer invading the spine



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HIGHLIGHTS

- Surgery for lung cancer invading the spine remains challenging.
- We describe our surgical approach and assess the outcome.
- We experienced eight patients who were treated with partial or total vertebrectomy.
- Five years overall survival rate was 71.4%.

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ABSTRACT

Background: Surgery for lung cancer invading the spine remains challenging associated with high morbidity and mortality. However, recent advances in surgical techniques as well as in perioperative care may improve outcomes of lung cancer surgery with vertebrectomy. We describe our surgical approach and assess the outcome lung cancer invading the spine.

Methods: We retrospectively reviewed our recent experiences of lung cancer with vertebral invasion, in which we have performed total or partial vertebrectomy from January 2011 through April 2015.

Results: We experienced eight patients who were treated with partial or total vertebrectomy for lung cancer. Vertebral invasion was evaluated by chest CT and MRI findings. All cases were no distant metastasis. N factors were all patients N0 revealed by chest CT and PET-CT. Two patients were treated preoperative induction therapy (CDDP + TS-1, Radiation 50 Gy). For the surgery, total vertebrectomy was performed two patients, hemi vertebrectomy was two patients, transverse-process resection was four patients. In all of eight cases, complete resection were performed with total or partial vertebrectomy. Morbidity was observed in six patients (75%); no mortality occurred. Six patients (75%) were survived after surgery (range: 12–62 months) and four patients (50%) were no recurrence. Five years overall survival rate was 71.4%.

Conclusions: In our experience, Lung cancer surgery combined with vertebrectomy is highly aggressive surgery associated with high morbidity. But, this procedure is a promising treatment option for selected patients, for example NOM0 disease with lung cancer invading the spine.

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1. Introduction

The treatment of patients for non-small cell lung cancer (NSCLC) with vertebral body invasion remains challenging and must be done high selected patients in high volume institution [1,9]. Resection of advanced NSCLC in stage IIIA–T4 have been associated with high morbidity and mortality combined with disappointing long-term results. Thus, the risk of surgical resection was not

Abbreviations: NSCLC, non-small cell lung cancer; CT, computed tomography; MRI, magnetic resonance imaging; PET, positron emission tomography; CDDP, cisplatin; CBDCA, carboplatin.

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justified by the outcome for many years [2]. Therefore, patients with NSCLC invading the spine historically have been considered to have unresectable disease [3]. Komaki et al. reported that direct vertebral invasion was considered to be a poor prognostic factor for superior sulcus tumors [4].

However, recent advances in surgical techniques as well as in perioperative care may improve outcomes of lung cancer surgery with vertebrectomy. Therefore, Selected patients were good prognosis treated surgery [1].

In this study, we showed recent surgical results of all eight patients. Complete resection with lobectomy and vertebrectomy was achieved in all cases. Especially, Case1 was performed total vertebrectomy and good prognosis [8]. Therefore, We encouraged to try vertebrectomy with lung cancer after that.

This operation is high morbidity. So that, we feasibility studied our experiences that vertebrectomy with lung cancer.

2. Materials and methods

We retrospectively reviewed our prospective database of all patients, who underwent lung resection with vertebrectomy for lung cancer between January 2011 and April 2015 at University of Occupational and Environmental Health hospital (one institution). Informed consent was obtained either from all patients. Follow-up data were obtained from record's most recent clinic visit.

2.1. Preconditions for the resection of lung cancer invading the spine

Preconditions for the resection of lung cancer invading the spine are as follows: (1) no N2 disease, (2) no distant metastasis, (3) induction therapy, as appropriate, depending on tumor board decision (including spine-specific orthopedic surgeon).

2.2. Diagnostic work-up

All patients underwent preoperative pulmonary and cardiac evaluation. Clinical staging included a computed tomography (CT) scan, magnetic resonance imaging (MRI), and positron emission tomography (PET). Vertebral invasion was evaluated by chest CT and MRI findings. Also, completely resectable disease was made decision with agreement by tumor board including spine-specific orthopedic surgeons.

2.3. Interdisciplinary surgical approach

The goal of surgery was complete resection of involved lung, chest wall and vertebrae with wide safety margins. All cases were performed vascular (intercostal artery and somatic artery around the vertebra) embolization before one operation's day.

The steps of our surgical approach are as follows:

1. First, we perform VATS to confirm resectability, for example, to confirm no pleural dissemination.
2. Second, Posterolateral thoracotomy with resection of the chest wall, and lung including systematic lymph node dissection.

Posterolateral thoracotomy was performed in the lateral decubitus position. The chest wall was resected anterior margin free section. After that, lobectomy and systemic lymph node dissection was performed.

Principally, en bloc resection of the tumor with lung, chest wall and vertebrae was ideal. However, if en bloc was difficult, intraleisional resections was performed.

3. Third, posterior midline incision with dorsal release for total vertebrectomy or partial vertebrectomy.

Posterior midline incision was performed in the prone position by the spine surgeon. Depending on extent of vertebra involvement evaluated on pre-surgical MRI, dorsal release was performed for partial or total vertebrectomy. After partial vertebrectomy, the nerve roots and accompanying segmental vessels were exposed and ligated inside the spinal canal to avoid cerebrospinal fluid leakage. In case of total vertebrectomy, pediculotomy and en block laminectomy were done. The intervertebral disks of the superior and inferior to the involved vertebral body are resected. These procedures were same of Schirren's operation [2]. After that, a titanium mesh case in conjunction with bone grafting and ventral osteosynthesis was done after total vertebrectomy.

All vertebrectomies were done by one orthopedic surgeon. Pathological examination confirmed the complete margin-free resection of lung cancer invading chest wall and vertebral body.

4. Finally, reconstruction of the chest wall.

The chest wall was always reconstructed using a double layer of polypropylene mesh (Bard Mesh, C.R. Bard Inc., Karlsruhe, Germany) also in neutral lateral position after placement of one chest tube. The mesh is sutured to the ribs. After that, the thoracotomy was closed.

2.4. Statistical analysis

A statistical analysis of the data was carried out using the Stat View software package (Abacus Concepts Inc., Berkeley, Calif., USA). The survival curves were estimated by the method of Kaplan and Meier.

3. Results

We experienced eight patients with vertebrectomy for lung cancer. N factors were all patients N0 revealed by chest CT and PET-CT. Also, completely resectable disease with agreement by tumor board including spine-specific orthopedic surgeons.

As appropriate, we performed induction therapy. The goal of surgery was complete resection of involved lung, chest wall and vertebrae.

We show surgical results of all eight patients. Complete resection with lobectomy and vertebrectomy was achieved in all cases including a previously reported case [8].

The median observation time was 32 months. Follow-up was available on all eight patients. The median age was 69 years (range 35–77 years). The group comprised six men and two women. Three had adenocarcinoma, three had squamous cell carcinoma, one had pleomorphic carcinoma, and one had small cell carcinoma.

Total vertebrectomy was done two patients, half resection vertebrectomy was two patients, transverse resection vertebrectomy was four patients (Fig. 1). The mean duration of operation was 17.1 h (range 9.8–33.3 h). The mean blood loss was 3861.3 ml (range 1750–7200 ml). Major postoperative complications were observed in six patients (75%). Both laryngeal recurrent nerve paralysis was occurred two patients. Empyema was occurred one patient. Bleeding which needed operation or drainage was two patients. Prolonged air leakage was one patient. There was no operative mortality (within 1 month after operation).

Pathological stages was pT3N0M0 were two patients, pT4N0M0 were six patients, Therefore, All patients were N0. Pathologically, vertebral invasion were four patients. Three patients who resected transverse resection were no invasive vertebral.

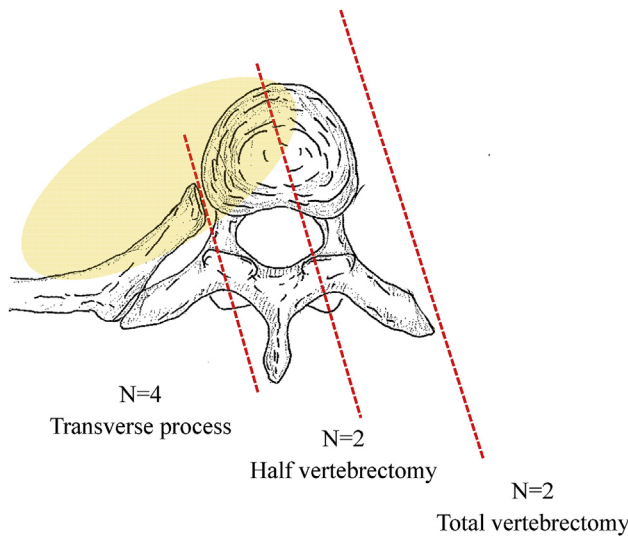


Fig. 1. Type of vertebrectomy for lung cancer invading the spine.

Two patients were treated by chemoradiation (CDDP + TS-1, radiation 50Gy) before surgery. Another two patients were treated adjuvant chemotherapy (CDDP + Docetaxel). Four patients were treated surgery alone.

In all of eight cases, complete resection were performed with total or partial vertebrectomy. Morbidity was observed in six patients (75%); no mortality occurred. Six patients (75%) were survived after surgery (range: 12–62 months) and four patients (50%) were no recurrence (Table 1).

Fig. 2 shows overall survival curves. Five years overall survival rate was 71.4%.

This data were immature because of short follow-up time. However, it is noted that case 1 and case 2 are alive without recurrence at more five and four years after surgery (Table 1, Fig. 2).

To summarize, all cases had no nodal metastasis. Six cases are alive, and four cases are alive without recurrence with a median follow-up of 32 months.

4. Discussion

In our experience, we note that this operation is a highly aggressive surgery associated with long operation time and high morbidity, but no mortality. R0 resection achieved was for NOMO disease in all cases. Six cases (75%) survive with the median follow-up of 32 months. Four cases (50%) survive without recurrence at maximum 62 months after surgery. Therefore, lung cancer surgery combined with vertebrectomy is highly aggressive surgery associated with high morbidity. But, This procedure is a promising treatment option for selected patients, for example NOMO disease with lung cancer invading the spine.

Local control, including a surgical resection, was the significant prognostic factor in the therapy of superior sulcus tumors [4]. Gandhi et al. and Grunenwald et al. reported aggressive multidisciplinary surgical approaches for superior sulcus tumors with vertebral invasion to have favorable survivals [6,7]. Their approaches were heterogenous, including pre or postoperative radiation, pre or postoperative chemotherapy, and induction chemoradiotherapy [6,7]. Schirren J et al. reported that multimodality treatment including en bloc lung resection with hemi-vertebrectomy or total vertebrectomy offers promising long-term survival in highly selected patients with NSCLC invading the spine

Table 1 Characteristics of patients undergoing resection for lung cancer invading the spine.

#	Age/ Sex	Induction therapy	Type of pulmonary resection	Type of vertebrectomy	Number of resected levels	Operation time (hour)	Complication	Histology	Pathological tumor stage	Completeness of resection	Adjuvant treatment	Status/ Recurrence	Follow-up (months)
1	35/ M	None	Lobectomy	Total	1(Th3)	17.5	None	Pleomorphic carcinoma	pT4N0M0	R0	Chemotherapy	Alive/None	62
2	67/ M	None	Lobectomy	Transverse	3(Th3-5)	9.8	Postoperative bleeding	Adenocarcinoma	pT3N0M0	R0	Chemotherapy	Alive/None	51
3	69/ F	None	Lobectomy	Transverse	4(Th3-6)	10.9	Air-leakage	Small cell carcinoma	pT3N0M0	R0	None	Alive/Brain metastasis	49
4	74/ M	None	Lobectomy	Transverse	2(Th2-3)	13.6	Postoperative bleeding	Adenocarcinoma	pT4N0M0	R0	None	Alive/None	33
5	46/ M	None	Lobectomy	Half	3(Th3-5)	19.0	Both recurrent nerve paralysis	Adenocarcinoma	pT4N0M0	R0	None	Alive/Lt adrenal metastasis	30
6	62/ M	Chemoradiation	Lobectomy	Total	1(Th2)	33.3	Both recurrent nerve paralysis	Squamous cell carcinoma	pT4N0M0	R0	None	Dead/Local recurrence	15
7	59/ M	Chemoradiation	Lobectomy	Half	2(Th3-4)	18.6	Both recurrent nerve paralysis, Empyema	Squamous cell carcinoma	pT4N0M0	R0	None	Dead/Local recurrence	17
8	77/ F	None	Lobectomy	Transverse	2(Th7-8)	14.3	None	Squamous cell carcinoma	pT4N0M0	R0	None	Alive/None	14

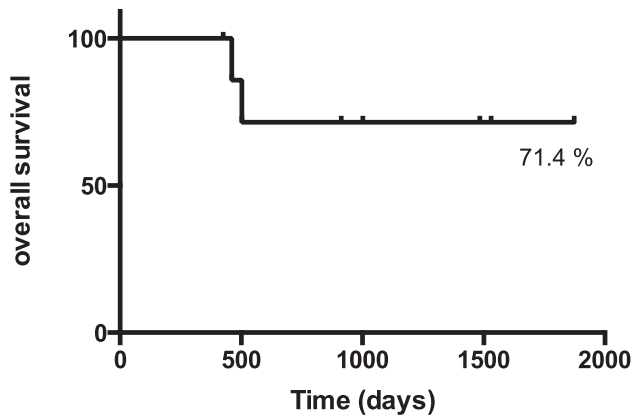


Fig. 2. Overall survival of patients undergoing resection for lung cancer invading the spine.

[2]. Incomplete resection and sublobar resections were associated with inferior survival, and he said that patients aged >70 years should be selected very carefully for radical resection for NSCLC invading the spine [2]. Yokomise et al. reported that surgery after induction therapy (Taxanes/carboplatin and 50Gy radiation) for vertebral invasion T4 NSCLC could therefore be performed with acceptable morbidity and mortality. To perform a partial vertebrectomy an enlarged posterolateral thoracotomy is useful and safe, if there is no invasion to the subclavian vessels [1]. In summaries their studies, surgical complete resection including vertebrectomy for invading spine for lung cancer might be useful procedure. But, indication for this surgery is very important, for example NO disease and patient's age <70. Induction or adjuvant therapy still hasn't been decided.

Vertebrectomy for lung cancer invading spine is very invasiveness. Therefore, operation step is important. We performed this operation's step as our methods. But, recent one case (Case 8) was ahead of dorsal release for partial vertebrectomy before thoracotomy. This case, we could smoothly and safety resect partial vertebra and process spinal nerve root. Schirren J et al. reported that they performed first dorsal release before thoracotomy [2]. This

procedure might be able to protect spinal nerve more safety than thoracotomy first. But, this procedure of dorsal release first is not able to judge dissemination or unresectable situation.

Recent four years, we experienced eight cases with lung cancer surgery combined with vertebrectomy. Preoperative induction chemoradiation therapy was performed in two cases. Therefore, this two patient who treated preoperative induction chemoradiation therapy was local recurrence (case 6 and 7). So that, it may be no useful for lung cancer patients with invading vertebra to do preoperative induction chemoradiation therapy.

It is unsure that the rule of use and regimen of induction and/or adjuvant treatment.

Next question is that operation procedures, for example, sequence of thoracotomy and vertebrectomy. We must solve these problems by acquiring further experience.

Conflict of interest statement

There were no conflicts of interest or financial interests for any of the authors.

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