Original Article

J. of Advanced Spine Surgery
Volume 8, Number 1, pp 26~36

JASS

Prognostic Factor Affecting the Survival Time for Patients Undergoing the Surgical Treatment for Spinal Metastases From Non-small Cell Lung Cancer

Chong-Suh Lee, M.D., Ph.D., Se-Jun Park, M.D., Sung-Soo Chung, M.D., Ph.D., Kyung-Jun Lee, M.D., Do-Koon Kim, M.D., Ji-Wun Lee, M.D., Jong-Hoon Kim, M.D., Tae-Hoon Yum, M.D.
Department of Orthopedic Surgery, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, Korea

Purpose: There were few available data regarding the prognosis after the surgical treatment for spinal metastases from non-small cell lung cancer (NSCLC) despite its great frequency. The aim of this study was to investigate the prognostic factors for patients who underwent the surgical treatment for spinal metastases from NSCLC.
Materials and Methods: Eighty-seven patients who underwent surgical treatment for spinal metastases from NSCLC were followed up semi-prospectively. There were 43 patients with metastatic spinal cord compression (MSCC) and 44 patients without MSCC. The prognosis analysis was performed according to 3-categorical variables: patients', oncologic, and treatments' factors. Major complications and mortality rate were recorded. The impact of postoperative chemotherapy was evaluated separately.
Results: The overall survival time was median 6.8 months. Postoperative ECOG-PS (0-2 vs. 3, 4) was shown as a significant prognostic factors in both MSCC and non-MSCC groups with HR (hazards ratio) of 2.46 and 2.54, respectively. Major complications developed in 26 patients and 30-day mortality rate was 8.0%. The presence of major complications was also prognostic factor in both groups with HR of 2.55 and 4.47. Earlier surgery within 72 hours showed better prognosis in MSCC group with HR of 2.46. Patients who underwent postoperative chemotherapy survived longer significantly than those who couldn't with median survival time of 12.0 vs 2.8 months.
Conclusions: Postoperative ECOG-PS and complications were significant prognostic factors in both groups and earlier surgery in MSCC group. The postoperative chemotherapy was another independent prognostic factor affecting the survival time

Keywords: Spinal metastases, Metastatic spinal cord compression, Non-small cell lung cancer, Surgical treatment, Chemotherapy

Introduction

Non-small cell lung cancer (NSCLC) is one of the leading causes of cancer-related death in men as well as women in the US and accounts for approximately 20% of spinal metastases.[1-3] The prognosis of advanced lung cancer is known to be poor with an expected survival inferior to 6 months.[1,3,4] Therefore, non-surgical treatment such as radiotherapy with or without corticosteroids has been preferred as the first-line therapeutic options for the treatment of spinal metastases from lung cancer.[5,6] However, physicians frequently encounter the patients who necessitate the surgical treatment due to metastatic spinal cord compression (MSCC), impending pathologic fracture, or disabling axial or radiating pain despite the conservative therapy. Selection

Corresponding author: Se-Jun Park, M.D.
Department of Orthopedic Surgery, Samsung Medical Center, Sungkyunkwan University School of Medicine, 81 Irwon-ro, Gangnam-gu, Seoul, 06351 Korea
TEL: +82-2-3410-1583, **FAX:** +82-2-3410-0061
E-mail: sejunos@gmail.com

of the optimal treatment for the each patient should be personalized based on the patient's condition especially in case of poor-prognosis tumors such as lung cancer. Recently, a number of studies have reported the favorable results after the surgical treatment for metastatic spinal tumors from various solid cancers.[7-12] However, these results from mixed populations might be hardly applicable for patients with a specific tumor type such as NSCLC.

Even though several prognostic analyses were performed focusing on spinal metastases from lung cancer, those results are somewhat limited because most of them included non-surgically treated patients, or focused on only MSCC, whose prognosis might differ from non- MSCC metastases.[13-16] To date, little has been known about the surgical treatment for those patients.

Physicians may feel burdensome to recommend the invasive treatments to patients even if the surgical treatments seemed to be necessarily required. This might be because of few data regarding its outcome and prognosis. Accordingly, this study was designed to investigate the prognostic factors for patients who underwent the surgical treatment for spinal metastases from NSCLC.

Methods

This is retrospective study using prospectively collected data pool between January 2006 and June 2017. The surgical treatments were performed for 418 patients with spinal metastases from various primary cancers by 5 spine surgeons in our spine unit. Among them, 87 patients of spinal metastases from NSCLC were enrolled in this study. 6 patients with small cell lung cancer (SCLC) were excluded for the homogenous assessment because it is known that the oncologic characteristics of NSCLC and SCLC are different.[17]

The most appropriate treatment options were decided after full discussion in spine tumor board among medical oncologists, radiation oncologists and spine surgeons. Decompression surgery was performed in most of the patients followed by the fixation procedures. The type of surgical procedure was determined by the location and extent of tumor. Table 1 listed the operated level and the different types of surgical procedure. When performing corpectomy, the vertebral body was replaced by titanium cages. Preoperative embolization was performed, if possible, especially when corpectomy was planned. Because the majority of surgery was performed in emergency setting, only 34 patients could undergo preoperative embolization.

Survival analysis was performed according to two groups: MSCC and non-MSCC group. MSCC group was defined as the patients who had metastatic cord compression with acute or subacute neurologic deficit and subsequent inability to walk independently. For each group, the analysis was done using 3-categorical parameters: patients' factor, oncologic factor, and treatments' factor. Patients' factors were age (≥60 vs. <60), gender, ambulatory status (ambulatory vs. non-ambulatory), Eastern Cooperative Oncology Group performance status (ECOG-PS: 0-2 vs. 3,4), and time from neurologic deficit to surgery (≤72 vs. >72 hours). Ambulatory status and ECOG-PS were evaluated preoperatively and at the first outpatient visit after discharge, which was around 1-2 months after surgery. Time from neurologic deficit was calculated as the duration from inability to walk independently to the surgery and recorded only for MSCC group. The oncologic factors included operated level (C- / T-/ L-spine), pathology type (adenocarcinoma vs. squamous cell carcinoma), number of spinal metastases (1, 2 vs.≥ 3), presence of extra-spinal bone metastases (yes vs. no), and presence of visceral metastases (yes vs. no). The treatment factors included surgery type (corpectomy vs. no corpectomy), preoperative embolization (yes vs. no), major complications (yes vs. no), preoperative chemotherapy (yes vs. no), and preoperative radiotherapy (yes vs. no).

We thought that the overall prognosis was also affected substantially by the postoperative chemotherapy, thus we evaluated whether the postoperative chemotherapy was done or not. However, we did not include it in the prognosis analysis model because the decision of chemotherapy would be made after considering multiple factors, and we could not control most of the factors perioperatively.

Perioperative major complications and mortality rate within postoperative 30-dyas were recorded. We excluded presumptive minor complications which were paralytic ileus (5 cases), transient superficial wound problems (3 cases), delirium (8cases), and transient radiating pain (2 cases).

Independent t-test and Chi-square test (or Fisher's exact test) were used to compare the preoperative baseline data

Table 1. Operated level and types of surgical procedure

Operated level	Approach	Procedures	No. of Patients
Cervical (n=16)	Ventral	Corpectomy + anterior fixation	11
	Dorsal	Posterior fixation ± laminectomy	5
Thoracic (n=54)	Ventral*	Corpectomy + anterior fixation	3
	Lateral	Corpectomy + anterior fixation	6
	Dorsal	Posterior fixation ± laminectomy	18
		Corpectomy + posterior fixation	27
	Lateral	Corpectomy + posterior fixation	3
Lumbar (n=17)	Dorsal	Posterior fixation ± laminectomy	10
		Corpectomy + posterior fixation	4

* In 3 patients, main pathologic level was located in T1 vertebra which could be approached by the conventional anterior cervical approach.

between MSCC group and non-MSCC group. Postoperative survival period up to June 2017 was calculated using the Kaplan-Meier method. The univariate analysis using log-rank test was performed to identify the difference of survival time for the presumed prognostic factors. Factors associated with survival time with a P value of less than 0.05 in the univariate analysis were entered in multivariate analysis using the Cox hazards proportional model. Statistical analysis was performed using SPSS software (version 21.0.0; SPSS Inc., Chicago, IL). P value less than 0.05 was considered as significance.

Results

A total study population consisted of 55 males and 32 females with a mean age of 58.9 ± 10.2 (range, 26-79). There were 43 patients with MSCC group and 44 with non-MSCC group (Table 2). Preoperative characteristics were not different significantly between MSCC and non-MSCC groups except the ambulatory status and ECOG-PS. In MSCC group, all patients could not ambulate independently and their ECOG-PS was 3- or 4-grades (Table 2).

The overall survival time after surgery was median 6.8 months (95% CI: 4.12-9.48). The estimated survival rates at 3, 6, 12 months were 71.1%, 52.6%, and 27.5%, respectively. The survival time was significantly longer in non-MSCC group than MSCC group with median survival time of 4.5 vs. 8.1 (p=0.005, log-rank test).

MSCC group

The estimated survival rates at 3, 6, and 12 months were 62.8%, 44.1%, and 18.5%, respectively. Twenty-eight of 43 patients regained the ambulatory capability, producing a rescue ratio of 65.1%. The time from neurologic deficit to the surgical treatment was 78.8 ± 48.3 hours (range, 18.0-216.0). ECOG-PS improvement by at least one grade was observed in 28 of 43 patients (67.4%). Postoperative ambulatory function, postoperative ECOG-PS, time from neurologic deficit, and the presence of major complication were presumed as prognostic factors on univariate analysis (Table 3). When these variables were submitted to multivariate analysis, postoperative ECOG-PS, time from neurologic deficit, and the presence of major complications were shown to be significant prognostic factors (Table 3).

Non-MSCC group

The estimate survival rates at 3, 6, and 12 months were 79.4%, 61.6%, and 40.4%, respectively. ECOG-PS improvement by at least one grade was observed in 27 of 44 patients (61.4%). In non-MSCC group, we found 2 prognostic factors on both univariate and multivariate analysis: postoperative ECOG-PS, and the presence of major complications (Table 4). The survival time according to the ambulatory status, preoperatively or postoperatively, seemed to affect the survival time, but those were not statistically significant (p=0.092 and 0.086, respectively).

Table 2. Preoperative Baseline data of each group

Characteristics	MSCC group (N=43)	Non-MSCC group (N=44)	p-value
Age	57.7±10.6	61.0±9.4	0.090
Gender			
M/F	25/18	30/14	0.379
Ambulatory status			
Ambulatoray / nonambulatory	0/43	32/12	-*
ECOG-PS			
0-2 / 3, 4	0/43	17/27	-*
Time from neurologic deficit (hours)			
≤72 vs. >72	20/23	-	
Operated level			
C-/T-/L- spine	4/31/8	12/24/8	0.087
Pathology type			
ADC / SCC	28/15	26/18	0.660
No. of spinal metastases			
1,2 / ≥3	15/28	20/24	0.384
Extraspinal bone metastases			
Yes / No	18/25	17/27	0.829
Visceral metastases			
Yes / No	21/22	19/25	0.669
Preoperative chemotherapy			
Yes / No	26/17	25/19	0.829
Postoperative radiotherapy			
Yes / No	24/17	18/26	0.087

MSCC: Metastatic spinal cord compression, ECOG-PS: Eastern Cooperative Oncology Group performance status, ADC : adenocarcinoma, SCC : Squamous cell carcinoma

*p-value was not calculated because the MSCC group had empty cells in cross tabulation for chi-square analysis.

Postoperative chemotherapy

The postoperative chemotherapy was performed 14 of 43 patients in MSCC group and 24 of 44 patients in non-MSCC group. The ratio of patients undergoing postoperative chemotherapy in both groups was not statistically different among each group (p=0.052, Fisher's exact test). Patients who could undergo postoperative chemotherapy survived longer than those who couldn't, with median survival time of 12.0 vs 2.8 months (p<0.001, log-rank test, Fig. 1).

Complications

The overall 30-day mortality rate was 8.0% (7 of 87). In 26 of 87 patients, major complications developed within postoperative 30 days. Among them, 4 patients experienced the surgery-related complications which were deterioration of neurologic deficit in 2 and surgical site infection in 2. Medical complications occurred in 22 patients, among whom 15 patients went through the fatal course. Most common medical complications were pulmonary problems such as pneumonia/pleural effusion/respiratory failure (14 patients). Others were sepsis (4), deep vein thrombosis (2), and rapid disease pro-

Table 3. Factors associated with survival time in MSCC group

Variables	Median survival*	p-value*	HR (95% CI)†	p-value†
Age				
≥60 vs. <60	4.5 vs 3.8	0.686		
Gender				
M vs. F	6.5 vs. 3.2	0.575		
Ambulatory status (Pre)				
Ambulatoray vs. nonambulatory	- vs. 4.5	-‡		
Ambulatory status (Post)				
Ambulatoray vs. nonambulatory	6.8 vs. 2.4	0.004	0.89 (0.35-2.23)	0.800
ECOG-PS (Pre)				
0-2 vs. 3, 4	- vs. 4.5	-‡		
ECOG-PS (Post)				
0-2 vs. 3, 4	7.3 vs 2.2	<0.001	2.46 (1.07-5.61)	0.033
Time from neurologic deficit (hours)				
≤72 vs. >72	7.1 vs. 3.1	0.008	2.08 (1.05-4.36)	0.046
Operated level				
C- vs. T- vs. L- spine	2.4 vs. 5.2 vs. 4.5	0.472		
Pathology type				
ADC vs. SCC	3.2 vs. 6.3	0.812		
No. of spinal metastases				
1,2 vs. ≥3	4.3 vs. 4.5	0.977		
Extraspinal bone metastases				
Yes vs. No	2.4 vs. 6.5	0.177		
Visceral metastases				
Yes vs. No	3.1 vs. 6.3	0.475		
Surgery type				
Corpectomy vs. no corpectomy	5.0 vs. 3.2	0.259		
Preoperative embolization				
Yes vs. No	4.3 vs. 4.5	0.857		
Major complication				
Yes vs.No	2.4 vs. 6.8	0.002	2.55(1.23-5.75)	0.024
Chemotherapy (Pre)				
Yes vs. No	3.2 vs. 5.0	0.514		
Radiotherapy (Pre)				
Yes vs. No	6.8 vs. 2.8	0.165		

HR: Hazards ratio, MSCC: Metastatic spinal cord compression, Pre: Preoperative, Post: Postoperative, ECOG-PS: Eastern Cooperative Oncology Group performance status, ADC : adenocarcinoma, SCC : Squamous cell carcinoma

*Median survival and p-values are calculated by log-rank test. †HR and P-values are calculated by Cox hazards proportional model. ‡P-values could not calculated because the absence of comparison group.

Table 4. Factors associated with survival time in non-MSCC group

Variables	Median survival	p-value*	HR (95% CI)	p-value†
Age				
≥60 vs. <60	8.1 vs. 13.4	0.870		
Gender				
M vs. F	8.1 vs. 7.0	0.588		
Ambulatory status (Pre)				
Ambulatoray vs. nonambulatory	9.9 vs. 2.5	0.092		
Ambulatory status (Post)				
Ambulatoray vs. nonambulatory	9.9 vs. 1.7	0.086		
ECOG-PS (Pre)				
0-2 vs. 3, 4	9.9 vs. 8.1	0.684		
ECOG-PS (Post)				
0-2 vs. 3, 4	10.9 vs. 2.0	0.035	2.54 (1.07-6.06)	0.035
Operated level				
C- vs. T- vs. L- spine	4.2 vs. 9.9 vs. 14.5	0.770		
Pathology type				
ADC vs. SCC	14.5 vs. 8.1	0.215		
No. of spinal metastases				
1,2 vs. ≥3	9.9 vs. 8.1	0.594		
Extraspinal bone metastases				
Yes vs. No	8.1 vs. 9.9	0.794		
Visceral metastases				
Yes vs. No	8.0 vs. 9.9	0.791		
Surgery type				
Corpectomy vs. no corpectomy	14.5 vs. 8.1	0.441		
Preoperative embolization				
Yes vs. No	8.1 vs. 9.9	0.677		
Major complications				
Yes vs. No	1.7 vs. 10.9	<0.001	4.47 (1.80-11.12)	0.001
Chemotherapy (Pre)				
Yes vs. No	6.9 vs. 10.8	0.241		
Radiotherapy (Pre)				
Yes vs. No	6.9 vs. 9.9	0.195		

HR: Hazards ratio, MSCC: Metastatic spinal cord compression, Pre: Preoperative, Post : Postoperative, ECOG-PS: Eastern Cooperative Oncology Group performance status, ADC : adenocarcinoma, SCC : Squamous cell carcinoma

* Median survival and p-values are calculated by log-rank test. † HR and P-values are calculated by Cox hazards proportional model.

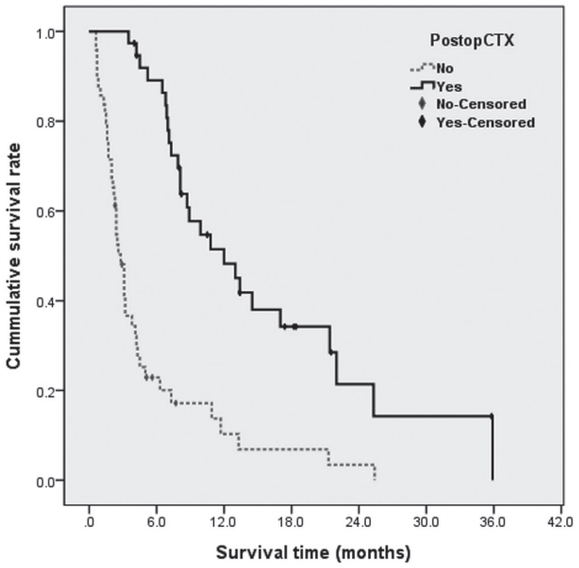

Fig. 1. Kaplan-Meier survivorship curve according to the postoperative chemotherapy.

gression (2 patients).

Discussion

Spinal metastases can present with severe pain or bony compromise that may eventually progress to the neurological deficit. Preventing and treating these subsequent events are of utmost importance in terms of maintaining the quality of life. Palliative measures such as vertebroplasty or radiotherapy and/or corticosteroid have been the primary lines of treatment.[5,6] However, the clinicians, both oncologists and spine surgeons, frequently encounter the patients who necessitate the surgical treatment due to metastatic spinal cord compression (MSCC), impending pathologic fracture, or disabling pain despite the conservative therapy. Given that the prognosis of metastatic lung cancer is known to be poor compared with that from other solid tumors such as breast cancer, prostate cancer,[3,18,19] the physicians tends to hesitate about the decision whether a burdensome treatment should be performed or not.

Recently, a number of studies have demonstrated that the surgical treatment for spinal metastases could provide good functional outcomes and maintain the quality of life along with improvement of modern surgical techniques.[7-12,19,20] However, these results are limited because most of these studies included the various primary tumors, which might be difficult to be applied to a specific cancer type. Only a few studies have been focusing on patients with spinal metastases from NSCLC.[13,14,16] Satoshi et al. reported that good performance status, low level of serum calcium, and high level of serum albumin were associated with better survival time.[16] Rades et al. showed that preoperative performance status, ambulatory status, visceral metastases, and time developing motor deficit were prognostic factors.[13,14] However, because the most of patients in those studies underwent the nonsurgical treatment, mostly radiotherapy, these results are also hardly applicable for the patients who require the surgical treatment. Thus, the current study was designed to provide the available information, focusing on the surgical treatment of spinal metastases from NSCLC.

As with other cancers, the primary treatment goal of surgical treatment of spinal metastases from NSCLC is to achieve the functional gain with modest complication rates and without compromising the remained survival time.[21] The personalized treatment can be offered by a balance between the morbidity and the estimated survival time. The overall median survival after surgery was 6.8 months with 6-month and 1-year survival rate of 52.6% and 27.5%, which was slightly superior to those of other reports studying the advanced lung cancer prognosis.[1,4,15,16,22] The better prognosis in our study can be explained by inclusion criteria. Our study included non-MSCC patients which were considered to be less compromised and to have better prognosis than MSCC patients. In our study, we observed that the survival time was significantly longer in non-MSCC group than MSCC group with median survival time of 4.5 vs. 8.1 (HR: 2.04, 95% CI: 1.23-3.40, p=0.005). The other reason would be the period of patients' enrollment. Because our study period spanned more recent time (up to 2016), more patients probably could take the recent medical treatments such as molecular target therapy.

The performance status and ambulatory capacity is a key component for maintaining quality of life.[12,23,24] In the current study, the improvement of ECOG-PS by at least 1 grade was observed in 67.4% in MSCC group and 61.4% in non-MSCC group. Twenty-eight patients (65.1%) who were not ambulatory preoperatively regained the ambulatory capacity after surgery in MSCC group. Our ambulation re-

sumption rate was comparable to that of the previous other studies, ranging 53-64%, although these studies included other primary tumors.[9,10,12,19] We also found that the earlier surgical timing is better for good prognosis in MSCC group. This finding about surgical timing has also been supported by the other studies.[8,11,25] Thus, for the patients who had MSCC, even in case of NSCLC, earlier surgical treatment should be delivered if the patient's condition is tolerable to the surgery.

Our study revealed the postoperative ECOG-PS was significant prognostic factors that affecting survival in both MSCC and non-MSCC group. It might not be surprising that the postoperative performance status was a significant prognostic factor. However, in the standpoint of the adjuvant medical treatment, keeping good performance status is one of the minimum requisites. The current study also showed that the patients who could undergo postoperative chemotherapy survived significantly longer than those who could not (median survival: 12.0 vs 2.8 months, $p<0.001$). Although the decision whether postoperative chemotherapy will be conducted or not would be made by medical oncologist after considering various factors, tolerable performance status is generally considered as a minimum requirement for undergoing the chemotherapy. The patients with good performance status will have a higher chance to take chemotherapy postoperatively. Thus, if we can improve the performance status by the surgical treatment, we could make more patients go through postoperative medical treatment and expect subsequent survival benefit. This study provides an important implication that the surgical treatment could improve the functional outcomes as well as play an adjuvant role to maintain the condition to go through postoperative medical treatment.

When considering the surgical treatment, estimating the complication rate is also of importance. In this study, major complications developed in 26 (29.0%) of 87 patients and 30-day mortality rate was 8.0% (7 of 87). The most common medical problems were pulmonary complications. Thus, the patients with deteriorated pulmonary function would not be the surgical candidates. The complication and mortality rates are comparable to the previous reports which studied various primary origins.[9,11] In a recent systematic review, Kim et al. reported that the overall complication rate was 29% (range, 5–65%), and the rate of mortality was 5% (range, 0–22%) within 30 days of surgery after the surgical treatment of metastatic spinal diseases[9]. From our results, major complications shortened the survival time significantly in both MSCC and non-MSCC group with HR of 2.55 and 4.47, respectively. Accordingly, once the surgical treatment is decided, it is imperative not only for surgeons but also for the medical team to pay great attention to prevent the perioperative complications.

Even if the patients were considered not eligible for surgery because of short life expectancy, if the general conditions were permitted especially with tolerable pulmonary function and with a further chemotherapy options remained, the active surgical treatment could be beneficial in terms of improvement of the functional status, increase of the chance for postoperative adjuvant therapy, and hopefully prolongation of survival time.

We acknowledge some drawbacks of this study. First, the sample size is relatively small. However, 87 patients may not be insufficient to draw the statistical significance, considering a majority of physicians tend to treat these patients non-operatively. Second, we did not address the detailed chemotherapy options including the molecular target therapy. Nowadays new target agents have been introduced and many of them are under the clinical trials. It has been reported that life expectancy could be prolonged even in the metastatic lung cancer along with advancements of medical oncology.[2,27-30] Thus, this study is limited because not all the patients could receive the current up-do-date medical treatments. Third, the decisions regarding the optimal treatments were not determined by uniform criteria. The decision making process would be different among the countries, cities, and hospitals according to their capacity to offer all available treatment modalities. We think this probable discrepancy about the treatment principles could be minimized through our face-to-face multidisciplinary team approach system.

In conclusion, postoperative ECOG-PS and complications were significant prognostic factors in both groups and earlier surgery in MSCC group. The postoperative chemotherapy was another independent prognostic factor affecting the survival time.

Compliance with Ethical Standards

Conflict of interest

The all authors in this study declare that they have no conflict of interest.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent

For this type of retrospective study, formal consent is not required.

REFERENCES

1. Siegel R, Naishadham D, Jemal A (2012) Cancer statistics, 2012. CA Cancer J Clin 62:10-29. doi:10.3322/caac.20138.
2. Morgen SS, Lund-Andersen C, Larsen CF, Engelholm SA, Dahl B (2013) Prognosis in patients with symptomatic metastatic spinal cord compression: survival in different cancer diagnosis in a cohort of 2321 patients. Spine (Phila Pa 1976) 38:1362-1367. doi:10.1097/BRS.0b013e318294835b.
3. Prasad D, Schiff D (2005) Malignant spinal-cord compression. Lancet Oncol 6:15-24. doi:10.1016/S1470-2045(04)01709-7.
4. Decroisette C, Monnet I, Berard H, Quere G, Le Caer H, Bota S, Audigier-Valette C, Geriniere L, Vernejoux JM, Chouaid C, Groupe Francais de Pneumo-Cancerologie T (2011) Epidemiology and treatment costs of bone metastases from lung cancer: a French prospective, observational, multicenter study (GFPC 0601). J Thorac Oncol 6:576-582. doi:10.1097/JTO.0b013e318206a1e3.
5. Janjan N, Lutz ST, Bedwinek JM, Hartsell WF, Ng A, Pieters RS, Jr., Ratanatharathorn V, Silberstein EB, Taub RJ, Yasko AW, Rettenmaier A, American College of R (2009) Therapeutic guidelines for the treatment of bone metastasis: a report from the American College of Radiology Appropriateness Criteria Expert Panel on Radiation Oncology. J Palliat Med 12:417-426. doi:10.1089/jpm.2009.9633.
6. Bartels RH, van der Linden YM, van der Graaf WT (2008) Spinal extradural metastasis: review of current treatment options. CA Cancer J Clin 58:245-259. doi:10.3322/CA.2007.0016.
7. Yamashita T, Aota Y, Kushida K, Murayama H, Hiruma T, Takeyama M, Iwamura Y, Saito T (2008) Changes in physical function after palliative surgery for metastatic spinal tumor: association of the revised Tokuhashi score with neurologic recovery. Spine (Phila Pa 1976) 33:2341-2346. doi:10.1097/BRS.0b013e3181878733.
8. Quraishi NA, Rajagopal TS, Manoharan SR, Elsayed S, Edwards KL, Boszczyk BM (2013) Effect of timing of surgery on neurological outcome and survival in metastatic spinal cord compression. Eur Spine J 22:1383-1388. doi:10.1007/s00586-012-2635-y.
9. Kim JM, Losina E, Bono CM, Schoenfeld AJ, Collins JE, Katz JN, Harris MB (2012) Clinical outcome of metastatic spinal cord compression treated with surgical excision +/- radiation versus radiation therapy alone: a systematic review of literature. Spine (Phila Pa 1976) 37:78-84. doi:10.1097/BRS.0b013e318223b9b6.
10. Ibrahim A, Crockard A, Antonietti P, Boriani S, Bunger C, Gasbarrini A, Grejs A, Harms J, Kawahara N, Mazel C, Melcher R, Tomita K (2008) Does spinal surgery improve the quality of life for those with extradural (spinal) osseous metastases? An international multicenter prospective observational study of 223 patients. Invited submission from the Joint Section Meeting on Disorders of the Spine and Peripheral Nerves, March 2007. J Neurosurg Spine 8:271-278. doi:10.3171/SPI/2008/8/3/271.
11. Kim CH, Chung CK, Jahng TA, Kim HJ (2011) Resumption of ambulatory status after surgery for nonambulatory patients with epidural spinal metastasis. Spine J 11:1015-1023. doi:10.1016/j.spinee.2011.09.007.
12. Patchell RA, Tibbs PA, Regine WF, Payne R, Saris S, Kryscio RJ, Mohiuddin M, Young B (2005) Direct decompressive surgical resection in the treatment of spinal cord compression caused by metastatic cancer: a randomised trial. Lancet 366:643-648. doi:10.1016/

S0140-6736(05)66954-1.

13. Rades D, Weber A, Karstens JH, Schild SE, Bartscht T (2014) Number of extraspinal organs with metastases: a prognostic factor of survival in patients with metastatic spinal cord compression (MSCC) from non-small cell lung cancer (NSCLC). Anticancer Res 34:2503-=07.
14. Rades D, Douglas S, Veninga T, Schild SE (2012) A validated survival score for patients with metastatic spinal cord compression from non-small cell lung cancer. BMC Cancer 12:302. doi:10.1186/1471-2407-12-302.
15. Chen YJ, Chang GC, Chen HT, Yang TY, Kuo BI, Hsu HC, Yang HW, Lee TS (2007) Surgical results of metastatic spinal cord compression secondary to non-small cell lung cancer. Spine (Phila Pa 1976) 32:E413-418. doi:10.1097/BRS.0b013e318074d6c7.
16. Ogihara S, Seichi A, Hozumi T, Oka H, Ieki R, Nakamura K, Kondoh T (2006) Prognostic factors for patients with spinal metastases from lung cancer. Spine (Phila Pa 1976) 31:1585-1590. doi:10.1097/01.brs.0000222146.91398.c9.
17. Pass HI, Carbone DP, Johnson DH, Minna JD, Turrisi AT, III. (2004) Lung Cancer: Principles and Practice, Lippincott Williams & Wilkins, Philadelphia.
18. Rades D, Abrahm JL (2010) The role of radiotherapy for metastatic epidural spinal cord compression. Nat Rev Clin Oncol 7:590-598. doi:10.1038/nrclinonc.2010.137.
19. Tancioni F, Navarria P, Pessina F, Attuati L, Mancosu P, Alloisio M, Scorsetti M, Santoro A, Baena RR (2012) Assessment of prognostic factors in patients with metastatic epidural spinal cord compression (MESCC) from solid tumor after surgery plus radiotherapy: a single institution experience. Eur Spine J 21 Suppl 1:S146-148. doi:10.1007/s00586-012-2232-0.
20. Lee CH, Kwon JW, Lee J, Hyun SJ, Kim KJ, Jahng TA, Kim HJ (2014) Direct decompressive surgery followed by radiotherapy versus radiotherapy alone for metastatic epidural spinal cord compression: a meta-analysis. Spine (Phila Pa 1976) 39:E587-592. doi:10.1097/BRS.0000000000000258.
21. Lee CS, Jung CH (2012) Metastatic spinal tumor. Asian Spine J 6:71-87. doi:10.4184/asj.2012.6.1.71.
22. Hessler C, Vettorazzi E, Madert J, Bokemeyer C, Panse J (2011) Actual and predicted survival time of patients with spinal metastases of lung cancer: evaluation of the robustness of the Tokuhashi score. Spine (Phila Pa 1976) 36:983-989. doi:10.1097/BRS.0b013e3181e8f7f8.
23. Chaichana KL, Woodworth GF, Sciubba DM, McGirt MJ, Witham TJ, Bydon A, Wolinsky JP, Gokaslan Z (2008) Predictors of ambulatory function after decompressive surgery for metastatic epidural spinal cord compression. Neurosurgery 62:683-692; discussion 683-692. doi:10.1227/01.neu.0000317317.33365.15.
24. Rades D, Rudat V, Veninga T, Stalpers LJ, Hoskin PJ, Schild SE (2008) Prognostic factors for functional outcome and survival after reirradiation for in-field recurrences of metastatic spinal cord compression. Cancer 113:1090-1096. doi:10.1002/cncr.23702.
25. Park JH, Jeon SR (2013) Pre- and postoperative lower extremity motor power and ambulatory status of patients with spinal cord compression due to a metastatic spinal tumor. Spine (Phila Pa 1976) 38:E798-802. doi:10.1097/BRS.0b013e3182927559.
26. Lee BH, Kim TH, Chong HS, Moon ES, Park JO, Kim HS, Kim SH, Lee HM, Cho YJ, Kim KN, Moon SH (2013) Prognostic factor analysis in patients with metastatic spine disease depending on surgery and conservative treatment: review of 577 cases. Ann Surg Oncol 20:40-46. doi:10.1245/s10434-012-2644-4.
27. Lopez-Olivo MA, Shah NA, Pratt G, Risser JM, Symanski E, Suarez-Almazor ME (2012) Bisphosphonates in the treatment of patients with lung cancer and metastatic bone disease: a systematic review and meta-analysis. Support Care Cancer 20:2985-2998. doi:10.1007/s00520-012-1563-z.
28. Cagle PT, Chirieac LR (2012) Advances in treatment of lung cancer with targeted therapy. Arch Pathol Lab Med 136:504-509. doi:10.5858/arpa.2011-0618-RA.
29. Carr LL, Finigan JH, Kern JA (2011) Evaluation and treatment of patients with non-small cell lung cancer. Med Clin North Am 95:1041-1054. doi:10.1016/j.mcna.2011.08.001.
30. Cagle PT, Allen TC, Dacic S, Beasley MB, Borczuk AC, Chirieac LR, Laucirica R, Ro JY, Kerr KM (2011) Revolution in lung cancer: new challenges for the surgical pathologist. Arch Pathol Lab Med 135:110-116. doi:10.1043/2010-0567-RA.1.

비소세포성 폐암의 척추 전이로 수술적 치료를 받은 환자에서 수술 후 생존 기간에 영향을 미치는 예후인자 분석

이종서, 박세준, 정성수, 이경준, 김도균, 이지운, 김종훈, 염태훈
성균관의대 삼성서울병원 정형외과

목적: 피소세포성 폐암으로 인한 척추 전이는 그 빈도가 많은에도 불구하고 이 질환 자체만을 대상으로한 수술적 치료 후의 예후에 관한 연구는 거의 없다. 따라서 본 연구에서는 피소세포성 폐암의 척추 전이로 수술적 치료를 받은 환자에서 수술 후 생존 기간에 영향을 미치는 예후인자들을 알아보고자 하였다.
대상 및 방법: 피소세포성 폐암의 척추 전이로 수술적 치료를 받은 87명의 환자를 대상으로 하였다. 이 중 43명은 전이성 척수 압박 때문에 수술을 받았으며 44명은 전이성 척수 압박은 없었다. 예후 분석은 환자인자, 종양인자, 치료인자 등의 3종류의 카테고리에 따라 분석하였다. 또한 주요 합병증 및 사망률을 평가하였다. 수술 후 항암치료가 예후에 미치는 영향을 독립적으로 분석하였다.
결과: 수술 후 전체적인 중위 생존기간은 6.8개월이였다. 수술 후 환자의 전신적인 활동도가 전이성 척수압박군과 그렇지 않은군 모두에서 유의한 예후 인자로 나타났다. 주요 합병증은 총 26명에서 발생하였고 30일내 사망률은 8%였다. 주요 합병증 유무 역시 두 군모두에서 유의한 예후인자로 나타났다. 전이성 척수압박군에서 72시간내의 조기 수술이 생존률에 양호한 결과를 보였다. 수술 후 항암치료를 받을 수 있었던 환자의 중위 생존기간은 12개월이었지만 그렇지 않은 환자의 생존기간은 2.8개월이었다.
결론: 수술 후 환자의 전신적인 활동도와 주요 합병증의 유무가 두 군모두에서 유의한 예후 인자로 나타났으며 전이성 척수 압박 군에서는 조기 수술이 유의한 예후 인자로 나타났다. 수술 후 항암 치료의 유무는 생존기간에 영향을 미치는 독립적인 예후 인자로 나타났다.

색인단어: 척추 전이, 전이성 척수 압박, 비소세포성 폐암, 수술적 치료, 항암 치료