

# Surgery for Metastatic Epidural Spinal Cord Compression in Thoracic Spine, Anterior or Posterior Approach?

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## Research Article

**Keywords:** Thoracic spine; metastatic epidural spinal cord compression; anterior thoracotomy; posterior approach; survivorship; neurologic status; complications

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# Abstract

**Background:** The most commonly encounter tumor of the spine is metastasis, and thoracic spine is the most commonly metastatic spine. Controversy exists regarding the optimal surgical approach for this kind of patient. The author conducted a study to assess the differences between anterior thoracotomy and posterior approach in patients with malignant epidural cord compression in the thoracic spine.

**Methods:** Between January 2003 and December 2015, patients with metastatic thoracic lesion underwent surgery at our department were stratified into two groups according to different approach method to the lesion site. Group A mean anterior thoracotomy, decompression and fixation. Group P represented posterior decompression and fixation. Survival was defined as months since surgery to last tractable times. American Spinal Injury Association grade was used to assess preoperative and postoperative neurologic status. Days at intensive care unit (ICU) were compared. Every complication by surgery or during admission was documented.

**Results:** Group A had 25 patients and Group P had 67 patients. Lung cancer was the most commonly origin cancer in both groups. The most commonly surgical level was the 9th thoracic vertebrae in Group A and the 10th thoracic vertebrae in Group P. Both groups had a similar preoperative neurologic ( $p=0.959$ ). One patient in Group A and two in the Group P sustained neurologic deterioration immediately after surgery. Group A took more operation time (213.0 vs 199.2 minutes,  $p=0.380$ ) and had more blood loss (912.5 vs 834.4 ml,  $p=0.571$ ). 6 patients in Group A (24%) and 10 patients in Group P (13.9%) developed complications immediately or postoperatively. Patients in Group A need more days of care at ICU (2.36 vs 0.19 days,  $p<0.001$ ). The longer survival was seen in the group P (15.4 vs 11.2 months) but without significant difference.

**Conclusion:** Patients in Group P required significantly less days of care at ICU. Besides, posterior approach also took a shorter surgical time, and had a less blood loss during surgery, although without statistically significant difference. According to the results, the author would prefer posterior approach by decompression and fixation for those with thoracic metastatic tumor with epidural compression.

**Keywords:** Thoracic spine; metastatic epidural spinal cord compression; anterior thoracotomy; posterior approach; survivorship; neurologic status; complications.

## Background

Metastatic tumors account for about 95% of all spinal tumors. This metastatic spinal lesion can destroy the spine, lead to loss of spinal stability, and invade into the canal with compression of the spinal cord, all of which causes pain and neurologic impairment. Approximately 70% of metastatic spinal tumors are found in thoracic spine, 20% in lumbar spine, and 10% in cervical spine [1]. Acute onset of metastatic epidural spinal cord compression (MESCC) usually needs immediate treatment. Intravenous injection of corticosteroid and local radiotherapy remain the standard treatment for MESCC. The role of surgery in the management of MESCC is merely palliative and is not a cure for metastatic tumors. Most spine surgeons

agree that direct decompression and tumor removal, followed by adequate fixation, benefits patients with MESCC [2,3]. However, the optimal surgical approach remains controversial. Three decades ago, a surgical procedure with an anterior approach was developed for the treatment of MESCC. The advantages of this anterior approach for MESCC are that tumors can be removed directly and reconstruction with a stable fixation can be performed simultaneously. Because most surgeons are familiar with a posterior approach and the development of a pedicle screw system, in the last two decades more and more articles have mentioned the posterior approach to MESCC by indirect decompression, removal of tumor mass through the pedicle, and fixation with posterior pedicle instrumentation [4,5]. With advancement of this technique, some surgeons could even perform a total en bloc spondylectomy for MESCC [6,7]. As far as we know, there is no literature comparing differences between anterior and posterior methods for MESCC with a focus on complications, neurologic status, and postoperative survival. In the present study, our patient database of thoracic metastatic spinal tumors for the past 15 years was examined to find out which surgical approach is the optimal method for patients with thoracic MESCC.

## Methods

From January 2003 to December 2015, patients with metastatic tumors in the thoracic spine who underwent surgical treatment in our department were reviewed retrospectively. All data was collected by accessing medical records. The inclusive criteria for the study were that patients must have suffered MESCC and received decompression, removal of tumor mass, and fixation with instrumentation. We excluded those patients who received biopsy only, pure laminectomy only, vertebroplasty (VP)/kyphoplasty (KP) only, and minimally invasive surgery with percutaneous pedicle fixation combined with VP/KP without the decompression procedure. One-stage or two-stage combined anterior and posterior methods were also excluded. According to the approach to the lesion site, patients were divided into anterior (A) and posterior (P) groups. Open surgeries were performed for these two groups and we describe the surgical methods for each briefly

In Group A, most patients were put into a right or left lateral decubitus position. The incision was made directly over the rib; then rib was removed from the tip of the costal cartilage to the angle of the rib. The parietal pleura was incised and the chest cavity was opened. The target vertebrae were identified and the tumor mass was removed to decompress the spinal cord. The vertebral space was reconstructed with polymethylmethacrylate (PMMA) cement and then one-above and one-below segmental fixation was applied to the anterior spine (Figure 1). The wound was closed with a chest tube left inside the chest cavity. Figure 1 demonstrates a case from Group A.

In Group P, the patients were put into the prone position and a posterior midline incision was performed. Usually, two segments above and two below the main involved segment were exposed. When the tumor mass was located over the posterior element only, tumor excision with laminectomy to decompress the spinal cord was adequate. When the tumor mass compressed the spinal cord via anterior vertebrae and/or pedicle, a wide laminectomy with bilateral facetectomies of the involved segment should be

performed. Then, the pedicles of the lesion segment were removed using a rongeur or high-speed burr; the tumor mass was removed by curettage and a pituitary rongeur via the removed pedicle. Finally, the pedicle screw instrumentation was applied to the posterior spine and a non-suction drain was left in. Figure 2 represents a case in Group P.

The revised Tokuhashi score [8] and the modified Bauer score [9] were used to record these patients' preoperative conditions. Data for both groups, including age, sex, operation time, blood loss during surgery, tumor level, origin of metastasis, stay in intensive care unit (ICU), receiving adjuvant radiotherapy or not, were recorded and compared. Patient outcomes were measured by survivorship, improvement in neurologic status, and the development of complications. The duration of survival was considered to be the time between the date of operation and death, or the date of the latest follow-up if the patient still survives. Neurologic function was evaluated preoperatively and postoperatively (when they were discharged or transferred to the Oncology department), and the neurologic status was assessed using the American Spinal Injury Association (ASIA) impairment score [10]: defined as being better or worse after surgery by at least one degree on the ASIA scale. Any perioperative or postoperative complications were recorded and analyzed in both groups, comparing the incidence of complications between the two groups. The institutional review board of Chang Gung Memorial Hospital approved this study and waived the requirement for informed consent due to the retrospective nature of the study.

## Statistical analysis

The Chi-square test and Fisher's exact t test were used for categorical variables. The student t test was used for continuous variables. A two-tailed value of  $p < 0.05$  was considered statistically significant.

## Results

A total of 97 patients were enrolled after screening 121 patients: 25 were treated with thoracotomy, removal of tumor mass, and fixation by bone cement and screw implant (Group A); the other 72 patients underwent posterior decompression, debulk of tumor mass, and pedicle screw fixation (Group P). There were no statistically significant differences in gender or age between these two groups. Preoperative Tokuhashi scores were  $7.6 \pm 3.2$  in Group A and  $8.4 \pm 2.6$  in Group P ( $p = 0.197$ ). The Bauer scores were also similar in both groups (Group A:  $1.76 \pm 0.97$ ; Group P:  $1.83 \pm 0.98$ ;  $p = 0.747$ ). Group A took more operating time ( $213.0 \pm 81.9$  min versus  $199.2 \pm 61.8$  min;  $p = 0.380$ ) and had more blood loss ( $912.5 \pm 834.1$  ml versus  $834.4 \pm 627.1$  ml;  $p = 0.571$ ), but without any statistically significant difference. A total of 14 patients in Group A (56%) and 38 patients in Group P (53%) received combined radiotherapy. The patients in Group A usually needed to stay longer in ICU, which was significantly different to those in Group P ( $2.36 \pm 3.49$  days versus  $0.19 \pm 0.70$  days;  $p < 0.001$ ). Basic demographic data between these two groups are outlined in Table 1.

Lung cancer was the main primary tumor in both groups (8 in 25 for Group A and 16 in 72 for Group P). The main level of vertebral body involved was from T5 to T9 in Group A. In contrast, the levels of vertebral

body decompression were more normally distributed in Group P, with T10 and T11 involved in most cases. Table 2 shows the primary tumors and the main surgical vertebrae for both groups.

## Complications

Six patients (24%) in Group A and ten patients (14%) in Group P developed complications. Each group had one patient who died within four weeks after surgery by controlled sepsis. The major postoperative complications in Group A were pulmonary problems such as pneumonia or being ventilator-dependent. There was no wound infection in Group A but wound-related complications were the main problem in Group P: four patients had wound infection, with three needing surgery to debride the infected wound. Another major complication in Group P was hematoma formation. Four patients experienced postoperative neurologic deterioration by hematoma formation and needed further surgery to decompress neurologic tissue by removing the hematoma.

## Neurologic status

Five patients in Group A and eleven patients in Group P were neurologically intact (ASIA E) preoperatively; the other 20 patients in Group A and 61 patients in Group P experienced a neurologic deficit (ASIA D, C, B, or A) before surgery: specifically, around 45% of patients in both groups who had not been able to walk (ASIA C, B, or A). Distribution of neurologic status was similar in both groups ( $p = 0.959$ ). One patient in Group A and two patients in Group P suffered neurologic deterioration immediately after surgery: massive hematoma formation was the main reason with the two patients in Group P; the reason was unclear for the Group A patient but over-manipulation of the spinal cord during surgery or inadvertent injury to a spinal chord feeding vessel was suspected. Overall, all patients in both groups who were neurologically intact before surgery remained neurologically normal. Eight patients in Group A (32%) and 20 patients in Group P (27.8%) improved by at least a grade; 15 patients in Group A (60%) and 43 patients in Group P group (59.7%) maintained the same neurologic level; and two patients in Group A (8%) and nine patients in Group P (12.5%) worsened neurologically by at least one degree on the ASIA scale. Postoperatively neurologic distribution in both groups was also similar ( $p = 0.416$ ). According to changes of neurologic function before and after surgery, both the anterior and posterior approach methods had no statistically significant differences ( $p = 0.800$ ). Table 3 represented data on neurologic changes in the two groups.

## Survival

In Group A, seven of the 25 patients survived for more than 1 year, but eight patients died within three months after operation. The rate of survival was 68% at three months, 48% at six months, 28% at 1 year, and only 12% at 2 years. The mean survival time was  $11.2 \pm 11.9$  months. In Group P, 27 of the 72 patients could survive for more than 1 year, but still 27 patients died within three months after surgery. The rate of survival was 62.5% at three months, 52.8% at six months, 37.5% at 1 year, and 19.4% at 2 years. The mean survival time was  $15.4 \pm 21.7$  months. The survival time was longer in Group P but there was no statistically significant difference ( $p = 0.358$ ). Figure 3 shows the postoperative survival for both groups using Kaplan-Meier curves.

## Discussion

The spine is the most common site of osseous metastasis. Spinal metastasis with pathologic fracture and spinal cord involvement are two frequent complications that spine surgeons usually are consulted on. The thoracic spine is often the site of these metastasis lesions, followed by lumbar spine and cervical spine. Even today, conventional external beam radiation remains the standard of care for painful vertebral metastasis. The role of surgery in cases of spinal metastasis is not to cure cancer but to alleviate patients' symptoms. Patchell et al. performed a randomized, non-blinded trial with 51 patients receiving surgery followed by radiotherapy and another 50 patients receiving radiotherapy only for their spinal cord compression caused by metastatic cancer [11]. The results showed that surgery plus radiotherapy reduced the need for corticosteroids and opioid analgesics, and significantly improved and maintained the ability to walk compared to radiotherapy only, confirming the positive effect of surgery on patients with spinal metastasis lesions.

The ideal goals of surgery include confirmation of primary diagnosis, decompression of neural elements, removal of tumor mass to allow for a more effective adjuvant therapy, and spinal stability to allow mobilization and prevent subsequent deformity. Many types of surgical approach have been advocated for treating spinal metastasis. Pure laminectomy was almost abandoned three decades ago because the stability of patients with metastatic lesions located at the vertebral body and pedicles is further reduced by removal of the posterior element. Constans et al. demonstrated that pure laminectomy had no benefit beyond radiotherapy in treating spinal metastasis [12]. The indication for pure laminectomy is very limited and usually for lesions over zone I and part of zone II according to the Weinstein classification [13,14]. With advancement of instrumentation and improvement in surgical techniques, many surgical methods have developed to provide exposure for more radical tumor resection than pure laminectomy. Reconstruction and fixation can be performed after these aggressive procedures through anterior or posterior approaches such as anterior transcavitary, posterior transpedicular, or total en bloc spondylectomy. The anterior transcavitary approach to MESCC is very reasonable because most metastasis lesions are at the body and pedicles of the vertebrae. This anterior approach provides wide exposure to remove the tumor mass directly and allow reconstruction using PMMA with a fixation device. Compared to pure laminectomy, an anterior approach could significantly improve pain, function, and neurologic status [15]. Chen et al. reported their experiences of 60 consecutive spinal metastasis patients undergoing anterior removal of tumor and fixation with a cement and plate system; the results showed that 71% of patients (40 in 56) got back pain relief over three months and 71% (33 in 42) had at least some degree of improvement in neurologic function; however, the report did not provide their survival data after surgery [16]. Gokaslan et al. studied 72 patients with spinal metastatic tumors who were treated with anterior transthoracic vertebectomy; the data revealed that the 30-day mortality rate was 3% and the 1-year survival rate was 62% [17]. In our study, the average survival time was 11.2 months and the 1-year survival rate was 40% (10 in 25) in the anterior group. The survival time in patients with MESCC was not only influenced by the surgical method but also by the origin of the primary tumor, the patients' general condition, receiving adjuvant therapy or not, etc. We believe that the higher ratio of lung cancer in the current study explains the lower survivorship compared to that found by Gokaslan et al. The complication

rate with open thoracotomy for MESCC was around 30% and our data was similar to previous literature. Huang et al. claimed that surgical complications for thoracic MESCC could be reduced to 13% (4 in 29) using their minimal invasive method, which is better than using the traditional thoracotomy approach to MESCC [18].

After developing the posterior pedicle fixation system, more and more surgeons tried to use laminectomy followed by posterior instrumentation for MESCC, which became popular because a posterior approach is familiar to most spine surgeons. With improvement in surgical techniques, a posterolateral approach to vertebrae has been developed to provide exposure for more radical tumor resection, and some surgeons have even developed a total en-bloc spondylectomy for MESCC. Bilsky et al. reported their experiences of 25 cases undergoing a posterolateral transpedicular approach with circumferential fusion for MESCC; the results showed that 23 patients had significant improvement of pain and neurologic status, with only one patient's neurologic function becoming worse immediately after surgery [19]. Wang et al. reported the largest case series containing 140 patients undergoing a single-stage posterolateral transpedicular approach with circumferential reconstruction for MESCC [20]. The results showed that operative complications occurred in 20 patients (14.3%), with wound complications in 16 patients being the main etiology of total complications; the overall median survival time was 7.7 months. The overall complication rate in Group P of the current study was 14%, which is similar to that found by Wang et al. Although wound infection was also the main aetiology of complications in Group P of the present study, the incidence (4 patients, 5.6%) was lower than that in Wang et al.; Wang et al.'s procedure was longer (5.1 hours versus 3.3 hours) and there was more blood loss (1500 ml versus 880 ml), which may have led to the higher incidence of wound complications. Furthermore, the average survival time in Group P of the current study was 15.4 months, which was far different to that of Wang et al. This phenomenon can be explained by the survival time in MESCC being influenced not only by the surgery but also by type of tumor origin, general condition of the patient, multiple metastasis or not, response to radiotherapy/chemotherapy or not, etc.

The development of total en bloc spondylectomy seemed to be a resolution for MESCC. The intent of this surgery is en bloc resection of the tumor with negative histologic margins. The procedure is highly demanding technically and has a high risk of neurologic injury [21]. Although the results of this technique have been encouraging in some studies of MESCC [22], most surgeons believe that total en bloc spondylectomy should be reserved for those patients where the surgery is being reserved for curative means rather than palliative. Therefore, controversy remains among spine surgeons over the role of total en bloc spondylectomy for MESCC patients.

In the current study, the results demonstrated that the anterior approach and posterior approach for MESCC seemed to be equivalent in terms of neurologic function, postoperative complications, and survivorship. However, there were still some subtle differences between these two approaches. First, more percentage of patients in the P group became neurologic deterioration because there were four patients in the P group had postoperative hematoma formation, which led to worse neurologic function finally. Second, total complication rate was higher in the A group (24% versus 14%) although without statistically

significant differences, most complications in the anterior group were associated to poor pulmonary problems, which resulted in a longer ICU stay in the anterior group.

## Conclusions

Patients in Group P required significantly less time in ICU than patients in Group A. Furthermore, the posterior approach for MESCC took less surgical time and there was less blood loss during surgery; there was also a longer survivorship, although this difference was not statistically significant. Based on the results of this study, the author preferred the posterior approach by transpedicular decompression and fixation for those with thoracic metastatic tumors and epidural compression.

## Abbreviations

MESCC: metastatic epidural spinal cord compression; VP: vertebroplasty; KP: kyphoplasty; PMMA: polymethylmethacrylate; ICU: intensive care unit; ASIA: American Spinal Injury Association

## Declarations

### **-Ethics approval and consent to participate**

This study was performed after obtaining approval from the institutional review board of Chang Gung Memorial Hospital (No. 108-0019B). The informed consent was waived by the IRB approval due to its retrospective nature.

### **-Consent for publication**

Not applicable

### **-Availability of data and materials.**

All the necessary information is contained in the manuscript. The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

### **-Competing interests**

The author has declared that there are no competing interests.

### **-Funding**

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### **-Authors' contributions**

Concept and design: Liao

Analysis and interpretation of data: Liao

Drafting the article: Liao

## **-Acknowledgements**

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## Tables

Table 1 Demographic Data

	Anterior Group	Posterior Group	P value
	(N: 25)	(N: 72)	
Age	9.4 ± 10.7	62.3 ± 10.3	0.233
Sex (F/M)	12 / 13	33 / 39	0.852
OP Time (minutes)	213.0 ± 81.9	199.2 ± 61.8	0.380
Blood loss (c.c)	912.5 ± 834.1	834.4 ± 627.1	0.571
Tokuhashi Score	7.6 ± 3.2	8.4 ± 2.6	0.197
Bauer Score	1.76 ± 0.97	1.83 ± 0.98	0.747
RT (Y/N)	14 / 11	38 / 34	0.781
ICU stay (days)	2.36 ± 3.49	0.19 ± 0.70	< 0.001
Complication (number)	6 (24%)	10 (13.8%)	0.241
Survival (months)	11.2 ± 11.9	15.4 ± 21.7	0.358

N=number; F=female; M=male; Op=operation; RT=radiotherapy; Y=yes; N=no; ICU=intensive care unit

Table 2 Tumor Origin and Main involved Level

	Anterior Group (N: 25)	Posterior Group (N: 72)
<u>Tumor Origin</u>		
Lung	8	16
Liver	4	4
Breath	2	9
Colon	3	9
Thyroid	1	3
Kidney	2	6
Prostate	1	10
Other	4	15
<u>T spine level</u>		
T1	1	0
T2	0	0
T3	0	4
T4	1	8
T5	3	7
T6	5	2
T7	3	5
T8	4	6
T9	6	6
T10	1	19
T11	1	10
T12	0	5

Table 3 Neurologic Status in Both Groups

	Anterior Group (N: 25)	Posterior Group (N: 72)	P value
<b><u>Pre-operation ASIA</u></b>			
A	1	4	
B	2	3	
C	8	27	0.959
D	9	27	
E	5	11	
<b><u>Post-operation ASIA</u></b>			
A	0	6	
B	4	5	
C	4	13	0.416
D	9	28	
E	8	20	
<b><u>Post-operation versus Pre-operation</u></b>			
I	8 (32%)	20 (27.8%)	
E	15 (60%)	43 (59.7%)	0.800
W	2 (8%)	9 (12.5%)	
<b>Neurologic Deterioration Immediately after Surgery</b>			
	1	2	0.761

ASIA= American Spinal Cord Injury Association; I=improve; E=equal; W=worse

## Figures

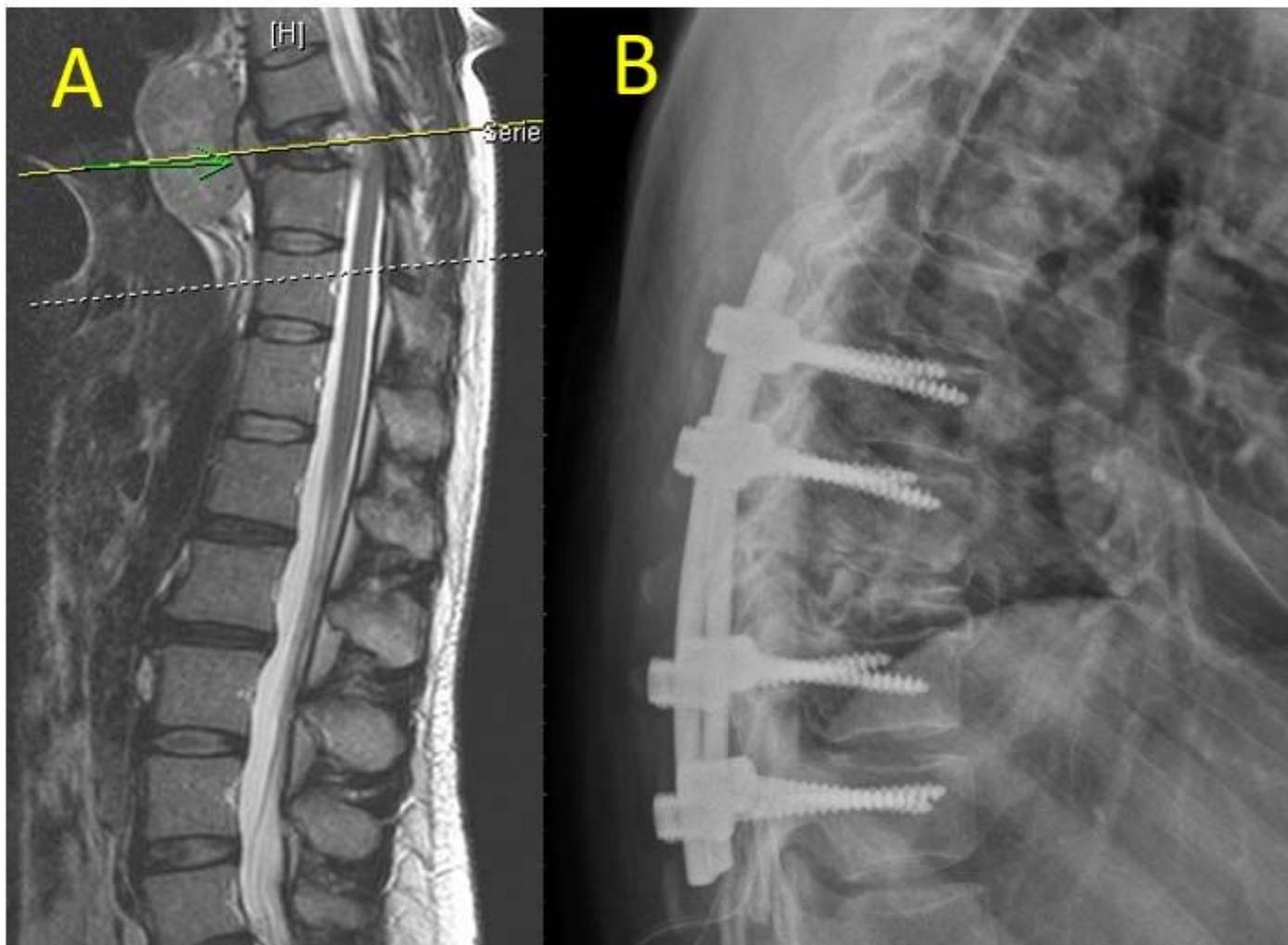
# Figure 1



**Figure 1**

The image showed a case in the anterior group. Preoperative magnetic resonance imaging revealed a T11 metastatic lesion compression spinal cord (Figure 1A). Anterior transthoracic approach, removal of tumor, and reconstruction with bone cement and screws were performed (Figure 1B).

# Figure 2



**Figure 2**

The image showed a case in the posterior group. Preoperative magnetic resonance imaging revealed a T9 metastatic lesion compression spinal cord (Figure 2A). Traditional posterior incision, laminectomy and posterolateral approach to decompress the tumor mass, and fixation by pedicle instrumentation (Figure 2B).

Figure 3

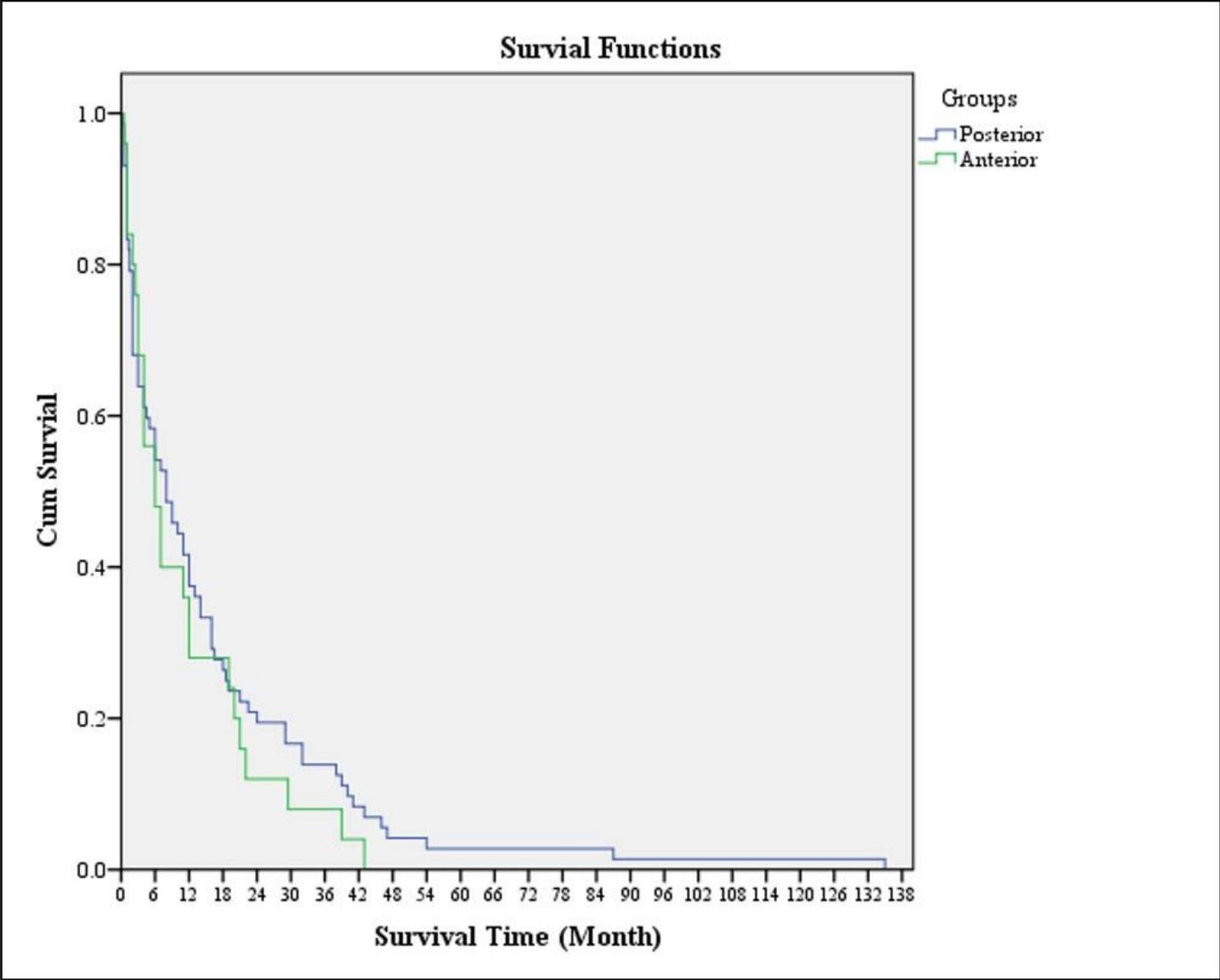


Figure 3

Graph showing Kaplan-Meier survival curve for patients in both groups. The green line represented anterior group (mean survival time:  $11.2 \pm 11.9$  months); the blue line represented posterior group (mean survival time:  $15.4 \pm 21.7$  months). P value = 0.358