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A Revised Scoring System for Preoperative Evaluation of Metastatic Spine Tumor Prognosis

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Study Design. A semi-prospective clinical study was conducted.

Objectives. To evaluate the accuracy of a revised scoring system predicting metastatic spinal tumor prognosis and the suitability of the subsequent treatment strategy.

Summary of the Background Data. We used a scoring system for the preoperative evaluation of the prognosis of metastatic spinal tumors and selected treatment methods for the predicted prognosis. In the previous version of our scoring system, the reliability of the predicting prognosis was 63.3% in 128 patients with metastatic spinal tumors.

Methods. The study participants were 164 patients who died after surgery and 82 who died after conservative treatment. Six parameters were used in the revised scoring system. Each parameter ranged from 0 to 5 points, and the total score was 15 points. In principle, conservative treatment or palliative procedures were indicated in patients with a total score of 8 or less (predicted survival period, less than 6 months) or those with multiple vertebral metastases, while excisional procedures were performed in patients with a total score of 12 or more (predicted survival period, 1 year or more) or those with a total score of 9 to 11 (predicted survival period, 6 months or more) and with metastasis in a single vertebra. The selection of treatment modality was followed faithfully according to the criteria of the revised scoring system after 1998. The prognosis predicted by the revised scoring system and the actual survival period after treatment were compared, and the reliability of the prognostic criteria was analyzed for the group subjected to it prospectively after 1998 (n = 118) and for all 246 patients it was applied to retrospectively.

Results. The total score for each patient could be correlated with the survival period. This correlation was also observed in each treatment group. The consistency rate between the predicted prognosis from the criteria of the total scores and the actual survival period was high in patients within each score range (0–8, 9–11, or 12–15), 86.4% in the 118 patients evaluated prospectively after 1998, and 82.5% in the 246 patients evaluated retrospectively. Furthermore, a similar result was also observed in both the surgical procedure group and conservative treatment group. The rate of consistency between the predicted-prognosis and the actual survival period in each local extension of the lesion was 75% or more in all types, excluding Type 6 in the surgical classification of Tomita et al.

Conclusion. The prognostic criteria using the total scores from our revised scoring system were useful for the pretreatment evaluation of metastatic spinal tumor prognosis irrespective of treatment modality or local extension of the lesion.

Key words: prognosis evaluation system, metastatic spine tumor, surgical indication, treatment modality. **Spine 2005;30:2186–2191**

Spinal metastases are systemic diseases with limited treatment methods. Therefore, predicting the prognosis is the most important and decisive factor in selecting the treatment modality.[1–8] Since 1987, we have used a point-addition-type scoring system for the preoperative prediction of the survival period to select treatment options.[3–5] In the previous version of our scoring system, the reliability of predicting prognosis was 63.3% in 128 patients with metastatic spinal tumors in 1997.[5] In addition, we did not evaluate the application of this assessment system for life expectancy for the group receiving conservative treatment. Therefore, we revised the scoring system to improve its accuracy as a prognosis evaluation system in 1998,[6] and magnified the application of this scoring system to the group with conservative treatment. In this study, the accuracy of the prognostic criteria using the revised scoring system was evaluated in relation to each parameter, total score, treatment modality, and lesion site.

■ Study Participants and Methods

Study Participants. There were 164 patients with metastatic spinal tumors who died after surgery and 82 who died after conservative treatment. The profiles of the subjects are shown in Table 1. The surgically treated patients were classified according to whether tumor excision was the main purpose for those who underwent palliative procedures (palliative procedure group) and those who underwent excision of vertebral body lesions (excisional procedure group).[6] In the palliative procedure group, the main purpose of surgery was spinal cord decompression/reconstruction rather than tumor excision, and posterior stabilization with decompression of the spinal cord or cauda equina from the posterior was primarily performed. Our recent standard procedure has been dural decompression of the entire circumference by tumor resection as much as possible by a posterolateral approach in combination with Cabtron ultrasonic surgical aspiration. In the cervical spine, anterior stabilization with anterior curettage, which provides good anterior support and correction, was sometimes performed as a pallia-

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Table 1. Patients Studied

Treatment Modality	No. of Patients
Palliative surgery (n = 142)	
Posterior decompression and stabilization	83
Posterior stabilization	34
Laminectomy	10
Palliative anterior curettage and stabilization	15
Excisional surgery (n = 22)	
Anterior curettage and stabilization	9
Combined curettage and stabilization	8
En bloc resection and stabilization	5
Conservative treatment (n = 82)	
Radiation	40
Chemotherapy	28
Hormonal therapy	5
Only analgesics	20

There were 154 male patients and 92 female patients. The average age was 56.5 years (range, 15–85 years). The site of lesion is as follows: 55 cervical patients, 142 thoracic patients, and 99 lumbosacral patients. The primary site of the cancer was as follows: lung 48, breast 26, kidney 24, liver 15, prostate 15, rectum 10, stomach 10, thyroid 7, uterus 6, colon 5, stomach 5, osteosarcoma 4, unidentified 34, others 37.

tive procedure.[6] Fifteen patients treated using this procedure were also included in the palliative procedure group (Table 1).

In the excisional procedure group, resection of the vertebral body lesion with spinal reconstruction was performed, aiming at *en bloc* resection of the tumor-affected vertebrae as far as possible. In principle, total *en bloc* spondylectomy through the posterior approach described by Tomita *et al*[7] was performed for thoracic lesions, and total *en bloc* spondylectomy through the anterior approach combined with the posterior approach for lumbar lesions. As an excisional procedure, aggressive curettage or subtotal resection with anterior stabilization through the anterior approach (excluding palliative anterior curettage with anterior stabilization), total *en bloc* spondylectomy through the posterior approach or total *en bloc* spondylectomy with a combined approach has been performed.

The conservative treatment group (Table 1) included only patients (examined by the first author) who had pain and paralysis but not surgical indication or did not give consent for surgery in the past 5 years. As conservative treatment, radiotherapy was performed in about 50% of the patients.

Revised Version of the Preoperative Evaluation System for the Prognosis of Metastatic Spinal Tumors. The total score of this revised version of the evaluation system was 15, which was the sum of the points of the following six items: general condition, number of extraspinal bone metastases, number of metastases in the vertebral body, presence or absence of metastases to major internal organs, site of the primary lesion, and severity of palsy (Table 2).[5,6]

The general condition was classified into three grades according to Karnofsky's performance status (PS).[9] Two points for a rating between 80% and 100% of PS is "good," 1 point for between 50% and 70% is "moderate," and 0 points for between 10% and 40% is "poor."

The number of extraspinal bone metastases and the number of spinal metastases were determined by both bone scintigraphy and MRI. When the number of metastases differed between these imaging techniques, the higher number was adopted. For a large area like the pelvis, the sites of uptake were counted as the number of metastases. Zero points were given when there were three or more such sites, 1 point when there was one or two, and 2 points when there were no other extraspinal bone metastases.

Table 2. Revised Evaluation System for the Prognosis of Metastatic Spine Tumors

Characteristic	Score
General condition (performance status)	
Poor (PS 10%–40%)	0
Moderate (PS 50%–70%)	1
Good (PS 80%–100%)	2
No. of extraspinal bone metastases foci	
≥3	0
1–2	1
0	2
No. of metastases in the vertebral body	
≥3	0
2	1
1	2
Metastases to the major internal organs	
Unremovable	0
Removable	1
No metastases	2
Primary site of the cancer	
Lung, osteosarcoma, stomach, bladder, esophagus, pancreas	0
Liver, gallbladder, unidentified	1
Others	2
Kidney, uterus	3
Rectum	4
Thyroid, breast, prostate, carcinoid tumor	5
Palsy	
Complete (Frankel A, B)	0
Incomplete (Frankel C, D)	1
None (Frankel E)	2

Criteria of predicted prognosis: Total Score (TS) 0–8 = >6 mo; TS 9–11 = ≤6 mo; TS 12–15 = ≤1 yr.

Although the presence or absence of metastases to major internal organs should be determined by chest CT, abdominal CT, and ultrasonography, the time to examination was often limited because of progressive pain or palsy; therefore, the presence of these metastases had to be determined based on the results of examinations that could be performed at that time. As a result, patients with no metastases to these organs scored 2 points, those with a metastasized lesion removable by surgery, 1 point, and those with metastases irremovable by surgery, 0 points.

The site of the primary lesion was graded from 0 to 5 based on the association between the site of the primary lesion and the mean survival period previously observed in patients who died after surgery (Figure 1).[5,6] As a result, 0 points were given to those with a primary lesion in the lung, osteosarcoma, stomach, bladder, esophagus, or pancreas, whose average period of survival was found to be less than 6 months. In this group, the key cancer was the primary site in the lung, which was most frequent in this series. On the other hand, in the group of patients whose average period of survival was found to be more than 1 year, 5 points were given to those with a primary lesion in the carcinoid tumor, thyroid, breast, or prostate. Although it was reported that the survival period of patients with rectum cancer metastases was not so long as patients with a primary lesion in the 5-point group, the survival period of patients with metastases was more than 1 year in our series. Therefore, patients with primary cancer in the rectum were grouped into the 4-point group. Groups with an average survival period of more than 6 months and less than 1 year were given 3 points, and they had kidney or uterine cancer. One point was given to those

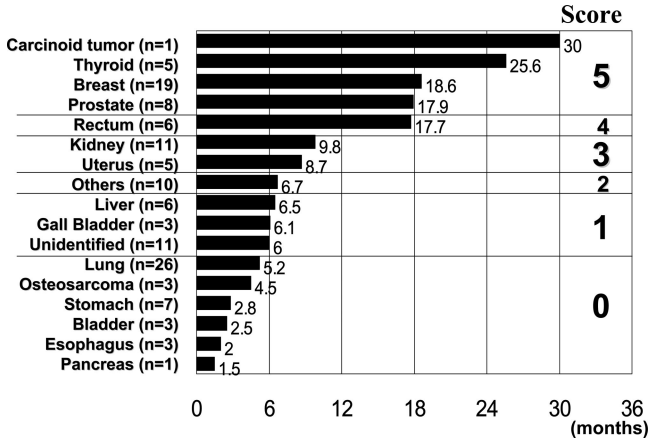

Figure 1. Association between the tumor origin and the average survival period after treatment until 1997. "Others" include primary lesions of colon (n = 2), ovary (n = 2), urethra (n = 2), melanoma (n = 1), germinoma (n = 1), liposarcoma (n = 1), and leiomyosarcoma (n = 1) in this series.

with cancer in the liver, gallbladder, or unidentified, whose average survival period was almost 6 months. In metastatic patients with one or two incidences, except patients with pancreas or carcinoid tumor, the primary lesions were colon (n = 2), ovary (n = 2), ureter (n = 2), melanoma (n = 1), germinoma (n = 1), liposarcoma (n = 1), and leiomyosarcoma (n = 1). The survival period of 10 patients ranged from 5.2 to 8.7 months, with a mean of 6.7 months. Therefore, they scored 2 points in this series. On the other hand, multiple myeloma or lymphoma was excluded from this series.

The severity of palsy was classified into three grades based on the findings of Frankel's classification: Frankel's A or B type was regarded as complete palsy, scoring 0 points; Frankel's C or D scored 1 point; and a neurologically normal condition scored 2 points.

Selection of Treatment Methods. In principle, treatment methods were selected with the highest priority given to the predicted survival period. Prognosis was evaluated based on the opinion of the oncologist and the preoperative prognostic score. In patients with a total score from our scoring system of 8 or less (predicted survival period, less than 6 months), conservative or palliative procedures were selected (Table 2). In patients with a total score of 12 or more (predicted survival period, 1 year or more), excisional procedures were selected. In patients with a total score of 9 to 11, excisional procedures were rarely indicated in a single lesion without metastases to the major internal organs (Figure 2).[6]

Surgery was not indicated in patients with a predicted survival period of 6 months or less who had a poor general condition, responded markedly to oral narcotic analgesics, showed marked effects of radiotherapy, had ultra-rapid progression of palsy (complete motor paralysis 2–3 days after onset), or had markedly lost the inclination to continue living. In patients with multiple metastases, conservative therapy was given priority.

Methods. Thirty-six of 164 who underwent surgery and 82 patients who received conservative treatment after 1998 were prospectively subjected to this revised scoring system. The treatment modality was faithfully selected using the criteria of

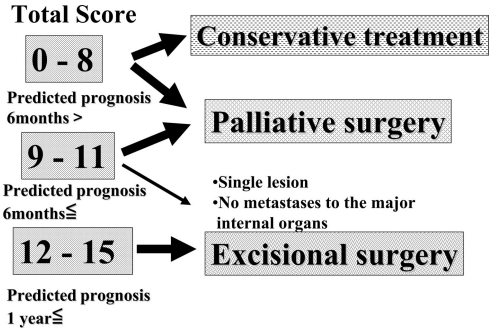

Figure 2. Strategy of treatment for spinal metastases.

the revised scoring system. The survival period predicted by the newly revised scoring system for the preoperative evaluation of prognosis and the actual survival period after treatment were compared, and we analyzed the reliability of the prognostic criteria of the revised scoring system. For life expectancy, total scores of 0 to 8, 9 to 11, and 12 to 15 were considered to predict survival periods of less than 6 months, 6 months or more, and 1 year or more, respectively, in the group that received it prospectively after 1998 and in all 246 patients who received it retrospectively. The association between local extension of the lesion and the reliability of the criteria was examined.

In addition, the possibility of using the criteria for the selection of treatment modality from the viewpoint of life expectancy was evaluated.

■ Results

Total Scores and the Survival Period After Treatment

In 246 patients, the survival period ranged from 10 days to 115 months, and the mean period of survival after treatment ± standard deviation (SD) was 8.7 ± 12.3 months. The mean of the total score was 9.8 in the excisional procedure group, 7.5 in the palliative procedure group, and 5.7 in the conservative treatment group. The mean survival period was 19 months in the excisional group, 9.5 months in the palliative group, and 4.9 months in the conservative treatment group.

Individual Scores Versus *the Average Survival Period for Each Parameter*

Comparison of the survival period among the patients within each score group (scores 0, 1, 2, 3, 4, and 5) for each item showed significant differences (analysis of variance) among some score groups. However, there was no item showing a significant difference among all score groups (Figure 3).

Total Score Versus *the Survival Period After Treatment*

The total score was significantly correlated with the actual survival period in all 246 patients ($y = -6.8 + 2.2x$, $r = 0.57$, $P < 0.0001$). This correlation was also observed in each treatment group (Figure 4).

Criteria for Predicted Prognosis From the Total Score Versus *the Survival Period*

Figure 5 shows Kaplan-Meier curves of the overall post-treatment survival according to the total score of the

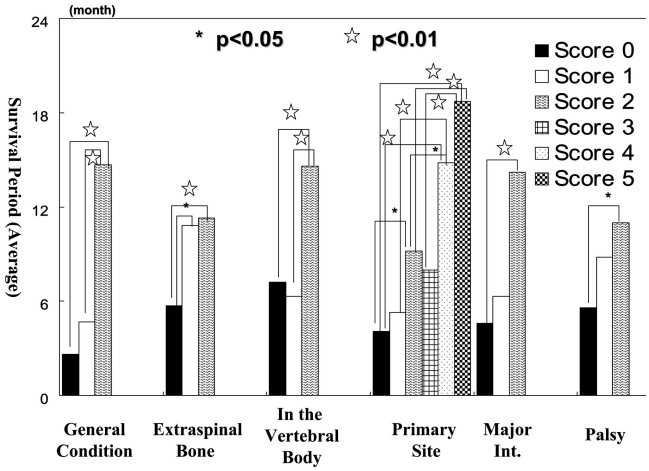

Figure 3. Comparison of the average survival period for each parameter. Extraspinal Bone = number of extraspinal bone metastases foci; In the Vertebral Body = number of metastases in the vertebral body; Primary Site = primary site of the cancer; Major Int. = metastases to the major internal organs. Significant difference among patients within each score group: $*P < 0.05$, $\star P < 0.01$.

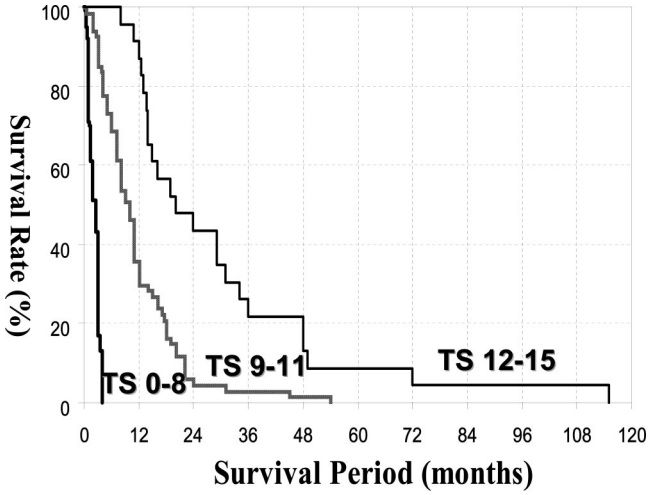

Figure 5. Kaplan-Meier curves of the survival period after treatment for patients with a total score of 0 to 8, 9 to 11, or 12 to 15.

groups. Analysis of variance showed significant differences ($P < 0.01$) in the mean survival period among the three groups (total score, 0–8, 9–11, and 12–15).

In the 118 patients (36 operations, 82 conservative treatments) evaluated prospectively after 1998, evaluation of the survival period after treatment according to the preoperative prognostic scoring system showed a survival period of less than 6 months in 89.0% of patients with a score of 0 to 8, a survival period of 6 months or more in 78.6% of those with a score of 9 to 11, and a survival period of 1 year or more in 87.5% of those with a score of 12 to 15. The rate of consistency between the prognostic score and the actual survival period was high in each treatment group (86.4% in all groups).

Furthermore, we evaluated all 246 patients retrospectively. As a result, evaluation of the survival period after treatment according the preoperative prognostic scoring system showed a survival period of less than 6 months in 85.3% of patients with a score of 0 to 8, a survival period of 6 months or more in 73.1% of those with a score of 9 to 11, and a survival period of 1 year or more in 95.4% of those with a score of 12 to 15 (Table 3). A similar tendency was observed in both the surgery group and the conservative treatment group. The rate of consistency between the prognostic score and the actual survival period was high in each treatment group (82.5% in all groups).

Reliability of the Criteria for Predicting Prognosis From the Total Score in Local Extension of the Lesion

The rate of consistency between the predicted prognosis and the actual survival period after treatment was evaluated according to the type of surgical classification[7,8] of Tomita *et al* as a classification of the local extension of the lesion. The consistency rate was 75% or more for all types excluding Type 6 (Table 4).

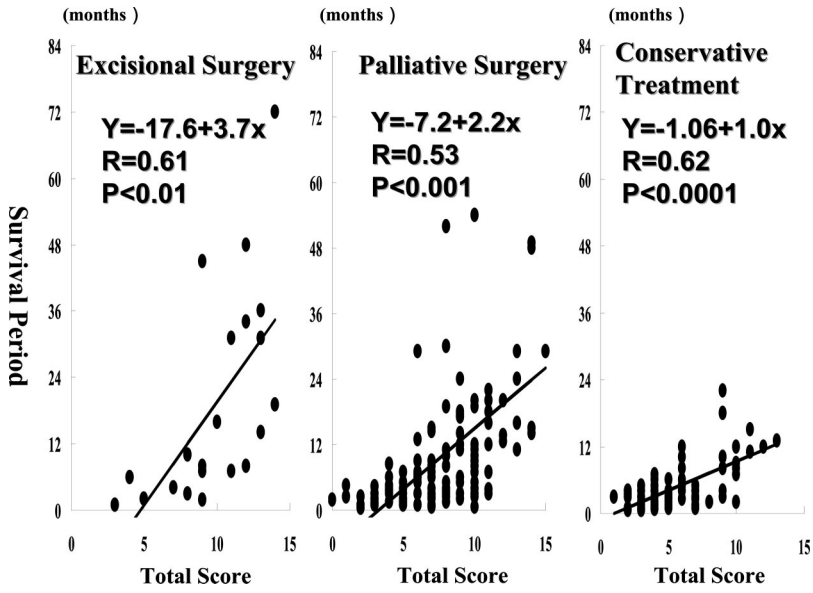

Figure 4. Correlation between the total score and the survival period in each treatment modality.

Table 3. Distribution of the Total Score and the Survival Period

	Survival Period		
Total Score	<6 mo	6 mo to 1 yr	>1 yr
0–8 (n = 156)	133 (85.3%)	16	7
9–11 (n = 67)	18	29	20 (73.1%)
12–15 (n = 23)		2	21 (95.4%)

*The 73.1% refers to the combination of the 29 and the 20 survivors in this row.

■ Discussion

Surgery has sometimes been indicated in recent years for patients with metastatic spinal tumors and is an excellent symptomatic treatment for pain relief and palsy, and quality of life that cannot be achieved by other methods can be gained instantly in selected patients.[1,3,5–8,10] When long survival can be predicted, surgical treatment aimed at the local resolution of metastatic lesions has been performed.[1,6,7] However, this is a systemic disease with limited treatment, and the main purposes of treatment are still pain relief and the improvement of palsy and activities of daily living.[1,3] In particular, surgery is limited in its improvement of severe progressive palsy and is a risky modality because its value may be lost if complications develop during or after surgery.[1,3,5,6,8,10] Therefore, at present, a treatment strategy and procedure selection based on life expectancy are the most rational,[1,3,4,6,8,10,11] and pretreatment prognosis evaluation is the most important determinant factor for selecting treatment methods including surgical procedures.

Recently, it has been said that the knowledge of the primary site of the cancer and its differentiation together with its TNM status at initial diagnosis would confidently predict prognosis. However, in symptomatic patients who require therapy, about one fifth of patients had no treatment history against cancer, and had primary symptoms that manifested as spinal metastases. Patients with an unidentified primary lesion comprised 34 of 246 patients (13.8%). Therefore, several patients were not suitable for the prediction of life expectancy using TMN status and pathologic findings. Furthermore, because of the rapid progress of pain or palsy, time is often limited for evaluating life expectancy by clarifying the extension of the lesion and the general condition of the entire body by minimal examination.[3,9,11] Appropriate consultation with oncologists and radiologists about the predicted prognosis and sensitivity to conservative treatment methods is indispensable; however, even after such consultations, accurate prediction is often difficult.[3,9,12–14] Although they are not oncologists, spinal surgeons can approximately predict the practical life expectancy of each patient and should select treatment modality, considering not only the oncologist's opinions but also their own prediction.

Table 4. The Rate of Consistency Between the Predicted Prognosis and the Survival Period After Treatment in Each Type of Local Extension of the Lesion According to the Type of Surgical Classification of Tomita *et al*[7,8]

Surgical Classification (Tomita *et al*, 1997)	Rate of Consistency Between the Predicted Prognosis and the Survival Period After Treatment (%)
Type 1 (n = 15)	93.3
Type 2 (n = 1)	100
Type 3 (n = 11)	81.8
Type 4 (n = 24)	87.5
Type 5 (n = 22)	77.3
Type 6 (n = 41)	63.4
Type 7 (n = 132)	85.6

Therefore, we developed a scoring system for the preoperative evaluation of the prognosis of metastatic spinal tumors that has been used clinically with minor revisions since 1987.[3–6] In this revised system, total scores of 0 to 8, 9 to 11, and 12 to 15 predict a life expectancy of less than 6 months, 6 months or more, and 1 year or more, respectively.[6] Using this system, the predicted life expectancy was consistent with the actual survival period after treatment in 86.4% in the prospective series of 118 patients, and in 82.5% in the retrospective series of all 246 patients. The consistency rates according to the methods (Figure 4) and the classification of the tumor extension (Table 4) were also high. Therefore, this scoring system may be useful for evaluating prognosis in clinical practice. This scoring system was originally developed based on postoperative patients but was also useful for patients with conservative treatment.[2]

Many scoring systems similar to our system for the preoperative evaluation of prognosis have been developed and their usefulness has been reported.[10–14] Therefore, it is clear that a prognosis evaluation system using a point-addition scoring system is useful for spinal metastases. We intend to further revise our scoring system to increase its accuracy by evaluating a greater number of cases and incorporating advances in treatment methods.

In addition, there are many patients with asymptomatic metastases to the spine that we cannot detect using current diagnostic imaging. Therefore, it is unclear whether patients with spinal metastases should be treated equally with symptomatic metastases and asymptomatic metastases. We have evaluated our assessment system for life expectancy in only symptomatic patients who required symptomatic treatment. At present, it is a significant problem how to treat subclinical metastases which are increasing year by year because of improvements in the detection of spinal metastases or bone metastases.

Furthermore, this system may also need to be combined with the evaluation of prognostic factors from other aspects such as the tumor type, the pathologic type, or the treatment state of the primary lesion. In addition, the treatment options against metastases have changed and increased with the progress of treatment, such as in hormonal tumors (breast cancer or prostate cancer). Therefore, other options may take the place of surgery. Optimally, a scoring system for

each primary tumor that is developed with oncologists is desired. Further revisions and improvements in accuracy are necessary.

■ Key Points

- We revised our scoring system for the preoperative evaluation of metastatic spinal tumor prognosis to improve its accuracy as a prognosis evaluation system.
- Six parameters were used in the revised scoring system: 1) the general condition, 2) the number of extraspinal bone metastases, 3) the number of metastases in the vertebral body, 4) metastases to the major internal organs (lungs, liver, kidneys, and brain), 5) the primary site of the cancer, and 6) the severity of spinal cord palsy. Each parameter ranged from 0 to 5 points, and the total score was 15 points.
- The consistency rate between the criteria for predicted prognosis and the actual survival period was high in patients within each score range (0–8, 9–11, or 12–15), 86.4% in the 118 patients evaluated prospectively after 1998, and 82.5% in all 246 patients evaluated retrospectively.
- The prognostic criteria of the revised scoring system were useful for predicting the prognosis irrespective of treatment modality or local extension of the lesion.

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