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TOPIC HIGHLIGHT

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Scoring system for prediction of metastatic spine tumor prognosis

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Abstract

Assessing the prognosis before treatment for metastatic spine tumor is extremely important in therapy selection. Therefore, we review some prognostic scoring systems and their outcomes. Articles with combinations of two keywords among "metastatic spine tumor" and "prognosis", "score", "scoring system", "predicting", or "life expectancy" were searched for in PubMed. As a result, 236 articles were extracted. Those referring to representative scoring systems about predicting the survival of patients with metastatic spine tumors were used. The significance and limits of these scoring systems, and the future perspectives were described. Tokuhashi score, Tomita score, Baur score, Linden score, Rades score, and Katagiri score were introduced. They are all scoring systems prepared by combining factors that affect prognosis. The primary site of cancer and visceral metastasis were common factors in all of these scoring systems. Other factors selected to influence the prognosis varied. They were useful to roughly predict the survival period, such as, "more than one year or not" or "more than six months or not". In particular, they were utilized for decision-making about operative indications and avoidance of excessive medical treatment. Because the function depended on the survival period in the patients with metastatic spine tumor, it was also utilized in assessing functional prognosis. However, no scoring system had more than 90% consistency between the predicted and actual survival periods. Future perspectives should adopt more oncological viewpoints with adjustment of the process of treatment for metastatic spine tumor.

Key words: Metastatic spine tumor; Prognosis evaluation system; Surgical indication; Treatment modality; Decision-making

Core tip: Some representative scoring systems for the prediction of metastatic spine tumor outcome were reviewed. Tokuhashi score, Tomita score, and others were introduced. They were useful to roughly predict the survival period, and were utilized for the purpose of decision-making about operative indications and the avoidance of excessive medical treatment. While the function in the patients was associated with the survival period, it was also useful to assess functional prognosis. However, no scoring system had more than 90% consistency between the predicted and actual survival periods. They also need a stronger oncological perspective with adjustment of the process of treatment.

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Table 1 Tokuhashi score original (1990)[1-3]

Predictive factor	Score (points)
General condition (KPS)	
Poor (KPS 10%-40%)	0
Moderate (KPS 50%-70%)	1
Good (KPS 80%-100%)	2
Number of extraspinal bone metastases foci	
≥ 3	0
1-2	1
0	2
Number 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, stomach	0
Kidney, liver, uterus, others, unidentified	1
Thyroid, prostate, breast, rectum	2
Spinal cord palsy	
Complete (Frankel A, B)	0
Incomplete (Frankel C, D)	1
None (Frankel E)	2
Total points	Mean survival periods
0-5	≤ 3 mo
6-8	≤ 12 mo
9-12	≤ 12 mo

KPS: Karnofsky's performance status.

INTRODUCTION

The objectives of treatment for metastatic spinal tumors are to mitigate pain and paralysis and maximize the activities of daily living (ADL) and quality of life (QOL) during the rest of life. The most important point regarding the therapeutic strategy is to predict the survival period accurately before treatment.

In the classification of the stage of cancers, the malignant tumours (TNM) classification is used for primary lesions, and approximate prediction of the survival period after detection and treatment of the primary lesion has been considered possible in most cancers. However, prediction of the survival period after the appearance of symptoms of spinal metastasis has not been satisfactory, unlike that after the detection and treatment of primary cancer.

Prediction of the survival period before treatment for spinal metastasis is extremely important for the selection of treatment. Naturally, the opinion of physicians of the department treating the primary lesion should be given priority, but their estimation of the survival period is not necessarily accurate, and the treatment should be determined by taking into consideration the estimations of orthopedists and radiologists, who are also directly involved in the treatment. For this purpose, some prognosis evaluation methods have also been developed by spine surgeons and radiologists, and scoring systems by which factors that affect the survival period are scored in an additive manner have been reported to be useful for assessing the prognosis.

Therefore, to evaluate the clinical significance and limitations in the prognostic scoring systems for metastatic spine tumors, we reviewed them and their validation studies that have been reported to date. Furthermore, it was verified which scoring system was the best. The review was conducted as follows; the literature was searched in PubMed using two-word combinations of "metastatic spine tumor" with "prognosis", "score", "scoring system", "predicting", and "life expectancy" as index terms. As a result, 236 papers were extracted. We checked their contents and describe representative scoring systems that correspond to "scoring systems for the prognosis of patients with metastatic spinal tumors" with comments on their significance and limitations. The representative prognostic scoring systems which we introduced were cited on PubMed more than at least five times. Also, as a result, it was considered the future of the prognostic scoring systems.

REPRESENTATIVE PROGNOSTIC SCORING SYSTEMS

Tokuhashi score

This system was reported by Tokuhashi *et al*[1-3] in 1989 as a "scoring system for the preoperative evaluation of a patient's prognosis with a metastatic spinal tumor". These papers have become landmark articles concerning prognostic scoring systems for patients with metastatic spinal tumors. A revised version was published in 2005[4], and the results of a prospective study in which the treatment was selected using this revised version were reported in 2009[5].

This scoring system consists of 6 items considered to affect the outcome (general condition[6], number of bone metastases other than spinal metastases, number of spinal metastases, type of the primary lesion, presence or absence of metastases to major organs, and state of paralysis). The survival periods were predicted from the total score using prognostic criteria (Tables 1 and 2). According to the original version, the estimated survival period was ≤ 3 mo when the total score was 0-5, ≤ 12 mo when the total score was ≤ 8, and ≥ 12 mo when the total score was ≥ 9. In the revised version, the staging of the primary lesion was changed from 3 (0-2) to 6 (0-5) levels, and the survival period was predicted to be ≤ 6 mo when the total score was 0-8, ≥ 6 mo when the total score was 9-11, and ≥ 1 year when the total score was ≥ 12.

In the original version, each item was scored as 0-2, but the hazard ratio was not evaluated for the weighting of the factors. Statistically, the survival period was retrospectively shown to be correlated with the total score in 47 surgical cases[1,2]. With both the original and the revised versions, relatively broad prognostic criteria were prepared, and their clinical application was proposed.

While this scoring system was insufficient on statisti-

Table 2 Revised Tokuhashi score (2005)[4]

Predictive factor	Score (points)
General condition (KPS)	
Poor (KPS 10%-40%)	0
Moderate (KPS 50%-70%)	1
Good (KPS 80%-100%)	2
Number of extraspinal bone metastases foci	
≥ 3	0
1-2	1
0	2
Number 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, prostate, breast, carcinoid tumor	5
Spinal cord palsy	
Complete (Frankel A, B)	0
Incomplete (Frankel C, D)	1
None (Frankel E)	2
Total points	Mean survival periods
0-8	< 6 mo
9-11	≥ 6 mo
12-15	≥ 12 mo

KPS: Karnofsky's performance status.

cal evaluation, the factors selected as affecting the survival period were relatively simple and easy to examine. In addition, it contained no factor concerning therapeutic intervention and was flexible on application. For this reason, it was applied for validation in various countries, and relatively favorable results have been reported[7-9].

Chen *et al*[10] reported that the revised Tokuhashi score was the most practical and provided the most accurate prognosis in 41 patients with spinal metastasis of hepatocellular carcinoma among 4 scoring systems: the revised score, Tomita score, Bauer score, and revised van der Linden score. Moreover, they suggested that the serum albumin and lactate dehydrogenase (LDH) levels are useful as prognostic factors.

Tokuhashi *et al*[5] also prospectively evaluated 183 patients treated according to the revised version, and reported that the prediction was in agreement with the actual survival period in 87.9% of the patients. In the revised version, the survival period was classified into 3 levels with 6 mo and 1 year, which are clinically important points, as benchmarks. According to these broad criteria, the prognoses for the moderate and favorable prognosis groups partially overlapped, but a score of 9-11 was erroneously converted to a survival period of 6 mo to 1 year in some papers[11-14], in which the agreement rate between the prognosis and actual survival period was low.

In addition, the rate of agreement between the predicted and actual survival periods differs depending on the type of primary lesion, and the usefulness of the criteria has been suggested to vary. Yamashita *et al*[15] (2011) reported that the predicted and actual survival periods agreed in 67 (79%) of 85 patients followed-up for 1 year or longer. In addition, they reported that the Tokuhashi score was useful regardless of the selected treatment. However, they observed that low scores were closely correlated with poor outcomes but that the outcome was more often poorer than predicted based on the score concerning the kidney, and suggested that the score allocation to the kidney was disproportionately heavy. On the other hand, Hessler *et al*[16] (2011) evaluated 76 patients who underwent surgery for spinal metastasis of lung cancer, and argued that the agreement rate between the survival period predicted according to the revised Tokuhashi score and the actual survival period was 67.1% and that the criteria did not reflect recent improvements in treatments for spinal metastases of cancer. They reported that some patients even with spinal metastasis of lung cancer survived for 1 year or longer and that the outcome was relatively favorable in those aged 50 years or less, those with metastasis in the lumbar spine, and those with no paralysis. Tokuhashi *et al*[5] basically agreed with Hessler *et al*[16], admitting that treatments had improved during the 13 years since the revised scoring system had been prepared and that some patients with spinal metastasis of lung cancer had survived for 2 years or longer. However, they maintained that the prognosis of patients with spinal metastasis of lung cancer is basically poor and that the precision of the score should be evaluated by including patients who tolerated only conservative treatments as well as those who underwent surgery[17].

Some papers focused on the accuracy of differentiation of good-prognosis, poor-prognosis, and intermediate groups. Quraishi *et al*[18] (2013) reported that 201 surgical cases could be differentiated into poor-, moderate-, and good-prognosis groups, that the agreement rate with the actual survival period was 64% or higher in each group and 66% in all patients, and that the usefulness of the score was moderate. However, in the 142 surgical cases reported by Pointillart *et al*[19] (2011), the agreement rate between the predicted and actual survival rates was 60% or lower with either the original or the revised version.

There have also been studies comparing the original and revised versions. Wang *et al*[20] (2012) considered that the revised version was particularly useful for the prognosis of patients with metastases of prostate and breast cancers and that the original version was excellent for the prognosis of patients with metastases of colon cancer. In addition, their usefulness was insufficient concerning metastases of lung or kidney cancers, and the overall accuracy was higher for the revised than the original version. However, Liang *et al*[21] (2013) reported that the original version was more useful than the revised version or Tomita score.

Kostuik[22] (1997) added 3 items: the radiographic appearance of the metastatic lesion, degree of kyphosis

Table 3 Tomita score (2001)[23,24]

Prognostic factors	Points
Primary tumor	
Slow growth (breast, thyroid, *etc.*)	1
Moderate growth (Kidney, uterus, *etc.*)	2
Rapid growth (Lung, stomach, *etc.*)	4
Visceral metastases	
Treatable	2
Untreatable	4
Bone metastases	
Solitary or isolated	1
Multiple	2
Total points	Predicted prognosis
2-4	> 2 yr
4-6	1-2 yr
6-8	6-12 mo
8-10	< 3 mo

of the secondary lesion, and rate of canal compromise secondary to the metastatic lesion, to the original version and reported the usefulness of this partially modified scoring system with a full mark of 18.

Tomita score

Tomita *et al*[23] and Kawahara *et al*[24] retrospectively evaluated 67 patients including those treated conservatively and developed a new scoring system in 2001 (Table 3).

Since the score of each item of the original Tokuhashi scoring system lacked weighting, each factor of each item was weighted by Cox hazard analysis in the new scoring system. Paralysis, which was considered not to affect the survival period, was excluded, and the new scoring system was simplified compared with Tokuhashi' s. In addition, the expected survival period and indicated treatment were 2 years or longer and en bloc excision, respectively, when the total score was 2-4, 1-2 years and debulking when it was 4-6, 6-12 mo and palliative decompression when it was 6-8, and 3 mo or less and terminal care when it was 8-10.

This scoring system is patient-centered and is often used along with Tokuhashi's system for evaluation of the surgical indication, and its usefulness has been evaluated in many reports[25-32].

Bauer[33] (2002) reported that this scoring system successfully differentiated poor- and good-prognosis groups but pointed out that it downplayed pain and paralysis, lacked specificity for impending paralysis, and disregarded indications for many conservative treatments and palliative surgery due to an excessive emphasis on aggressive surgical treatments.

Baur scoring system

In 1995, Bauer *et al*[34] developed a simple scoring system by studying 153 cases of limb bone metastases and 88 cases of spinal metastases by combining 3 influential items selected by univariate analysis and Cox regression analysis of prognostic factors: the site of the primary tumor, metastatic load, and pathologic fracture (Table 4).

Table 4 Baur score original

Positive prognostic factors	Score (Points)
No visceral metastases	1
Absence of pathologic fracture	1
solitary skeletal metastasis	1
No lung cancer	1
Primary tumor = breast, kidney, lymphoma, multiple myeloma	1
Total score (points)	1-yr survival rate (%)
0-1	0% (< 6 mo survival)
2-3	25%
4-5	50%

Table 5 Modified Baur score

Positive prognostic factors	Points
No visceral metastases	1
No lung cancer	1
Primary tumor = breast, kidney, lymphoma, multiple myeloma	1
One solitary skeletal metastasis	1
Total points	Median overall survival
0-1	4.8 mo
2	18.2 mo
3-4	28.4 mo

As a result, the 1-year survival rate was predicted to be 0% when the score was 0-1 (all patients die within 6 mo), 25% when it was 2-3, and 50% when it was 4-5.

Disadvantages of this scoring system are that the judgment of pathologic fracture is difficult in the spine and that it was developed based on a multi-center collaborative study restricted to surgical cases with large variations in the surgical indications and procedures among the facilities.

However, Leithner *et al*[35] (2008) and Wibmer *et al*[36] (2011) considered that, of the 7 scoring systems including the Tokuhashi, Tomita, and Linden scoring systems, those other than the Bauer scoring system were also useful until 4 years after treatment. However, they reported that the Bauer score and modified Bauer score (Table 5), in which the item concerning the presence or absence of pathologic fracture was excluded, were superior for the prognosis after 4 or more years and differentiation between the good- and moderate-prognosis groups[35,36]. According to the modified Bauer score, the median OS and indications for treatment are 4.8 mo and no surgical indication, respectively, when the score is 0-1, 18.3 mo and palliative surgery from a posterior approach when the score is 2, and 28.4 mo and control by a combination of anterior and posterior approaches when the score is 3-4.

Van der Linden scoring system

In 2005, van der Linden *et al*[37] devised a scoring system consisting of 3 items: Karnofsky's performance status, type of primary lesion (lung cancer, breast cancer, prostate cancer, others), and the presence or absence of visceral metastasis, by studying 342 cases of spinal metas-

Table 6 Linden score

Prognostic factors	Points
Karnofsky performance status	
80-100	2
50-70	1
20-40	0
Primary tumor	
Breast	3
Prostate	2
Lung	1
Other	0
Visceral metastases	
No	1
Yes	0
Total points	Mean overall survival
0-3 (n = 116)	4.8 mo
4-5 (n = 164)	13.1 mo
6 (n = 62)	18.3 mo

Table 7 Rades score

Prognostic factor	Score (points)
Type of primary tumor	
Breast cancer	8
Prostate cancer	7
Myeloma/lymphoma	9
Lung cancer	3
Other tumors	4
Other bone metastases at the time of RT	
Yes	5
No	7
Visceral metastases at the time of RT	
Yes	2
No	8
Interval from tumor diagnosis to MSCC	
≤ 15 mo	4
> 15 mo	7
Ambulatory status before RT	
Ambulatory	7
Nonambulatory	3
Time of developing motor deficits before RT	
1-7 d	3
8-14 d	6
> 14 d	8
Total score	6-mo survival (%)
20-30 (n = 237)	16
31-35 (n = 162)	48
36-46 (n = 253)	81

RT: Radiotherapy; MSCC: Metastatic spinal cord compression.

tasis (Table 6), and reported that it was effective in 73% of the patients[37].

Rades score

Rades *et al*[38] prepared a few scoring systems on the basis of data obtained from patients who underwent radiation therapy for spinal cord compression by metastatic tumors, all by Cox proportional-hazards survival analysis. The first and largest of them was derived from 1852 cases (2008, Table 7)[38], followed by one derived from a prospective study of 439 cases (2010, Table 7)[39] and a scoring system based on the type of cancer. There is also a scoring system for metastases of prostate cancer (2012, Table 8)[40], one for metastases of breast cancer (2013, Table 9)[41], and one for unknown primary lesions by Douglas *et al*[42] (2012, Table 10).

All are for the evaluation of conditions that are indications of radiation therapy for spinal cord compression by metastatic tumors at an advanced stage and consist of other bone metastases at the time of RT, visceral metastases at the time of RT, the interval from tumor diagnosis

Table 8 Rades score for prostate cancer metastases

Prognostic factor	Score (points)
ECOG performance status	
1-2	9
3-4	4
Ambulatory status prior to RT	
Not ambulatory	4
Ambulatory before RT	8
Other bone metastases	
No	7
Yes	5
Visceral metastases	
No	8
Yes	2
Interval from cancer diagnosis to RT	
≤ 15 mo	5
> 15 mo	7
Score group	Survival at 6 mo (%)
20-24 (n = 58)	6.5-7.4
25-34 (n = 189)	44.6-45.4
35-39 (n = 189)	94.7-95.8

ECOG : Eastern Cooperative Oncology Group. RT: Radiotherapy.

Table 9 Rades score for breast cancer metastases

Prognostic factor	Score (points)
ECOG performance status	
1-2	9
3-4	5
Ambulatory status prior to RT	
Not ambulatory	4
Ambulatory before RT	8
Other bone metastases	
No	8
Yes	7
Visceral metastases	
No	9
Yes	4
Interval from tumor diagnosis to radiotherapy of MSCC	
≤ 15 mo	6
> 15 mo	8
Time of developing motor deficits	
1-7 d	4
> 7 d	8
Total score	Survival at 6 mo (%)
30-35	12-14
36-40	41-46
41-45	74-77
46-50	98-99

ECOG: Eastern Cooperative Oncology Group. RT: Radiotherapy; MSCC: Metastatic spinal cord compression.

Table 10 Douglas score for unknown primary metastases

Prognostic factor	Score (points)
ECOG performance status	
1-2	6
3-4	2
Ambulatory status prior to RT	
Not ambulatory	2
Ambulatory before RT	4
Visceral metastases	
No	5
Yes	0
Time of developing motor deficits	
1-7 d	1
> 7 d	5
Score group	Survival at 6 mo (%)
< 14 (n = 112)	5-7
14-16 (n = 26)	38-41
> 16 (n = 24)	91-92

ECOG: Eastern Cooperative Oncology Group. RT: Radiotherapy.

Table 11 Katagiri score

Prognostic factor	Score
Primary lesion	
Rapid growth(Hepatocellular carcinoma, gastric carcinoma, lung carcinoma)	3
Slow growth(Breast carcinoma, prostate carcinoma, multiple myeloma, malignant lymphoma, thyroid carcinoma)	0
Moderate growth(Other carcinoma and sarcoma)	2
Visceral or cerebral metastases	2
Performance status (ECOG) 3 or 4	1
Previous chemotherapy	1
Multiple skeletal metastases	1
Total score (n = 350)	6 and 12 mo survival rate (%)
0-2	97.9; 89.1
3-5	70.6; 48.8
6-8	31.3; 10.9

ECOG: Eastern Cooperative Oncology Group.

to metastatic spinal cord compression (MSCC), ambulatory status before RT, and time of developing motor deficits before RT, but they vary in their combination and allocation of scores depending on the cancer type. Important points regarding this scoring system are that its application is restricted to an advanced stage of spine metastases of cancer with impending paralysis, and that the prediction of the outcome for patients with some cancer types is impossible with a single pattern. In addition, the therapeutic options are restricted to radiation therapy, and the scoring systems cannot be applied to the selection of diversified treatments for spinal metastases of cancer.

Katagiri score

Katagiri score is a scoring system prepared retrospectively by Cox proportional-hazards analysis of 350 cases of skeletal metastases (2005, Table 11)[43]. Its unique characteristics not observed in other scoring systems are that the history of chemotherapy before the crises of metastases is incorporated and bone metastases are captured as metastases of the entire skeleton rather than of the spine alone. For this reason, only 37 patients (10.6%) underwent surgery due to spinal metastases.

The greatest demerit of this scoring system is that it includes the history of chemotherapy, a therapeutic intervention, and that the evaluation of the degree of intervention and sensitivity for each cancer is unclear. It is likely to be affected by individual variation in attending physicians and has major problems with versatility and objectivity.

SIGNIFICANCE OF, AND PROBLEMS WITH, SCORING SYSTEMS

All scoring systems for the prognosis of patients with metastatic spinal tumors are composed of combinations of factors that affect the survival periods. Among these prognostic factors, the type of primary lesion and visceral metastases are included in all scoring systems, and other factors are arbitrarily selected. Rades *et al*[38-41] and Douglas *et al*[42] attached importance to functional factors and reported a scoring system incorporating the ambulatory ability before treatment and speed of progression of paralysis, but many scoring systems, including one by Tomita *et al*[23], Bauer *et al*[34], van der Linden *et al*[37] and Katagiri *et al*[43], totally disregarded paralysis. This wide variation is considered to have been due to differences in the patients evaluated for the preparation of the scoring systems. The patients studied by Rades *et al*[38] consisted entirely of those who had progressive spinal cord paralysis and underwent radiation therapy, and included a high percentage of those with a poor prognosis in whom the surgical indication could not be evaluated from the beginning. Therefore, the prognosis of patients with progressive paralysis based on this system is considerably poorer than that by other scoring systems. As suggested by Kawai *et al*[44] (2013), reevaluation of prognostic factors is considered necessary based on the historical background that asymptomatic metastases detected in an early stage began to be treated as new metastases.

At any rate, it is certain that such additive scoring systems combining factors considered to affect the outcome are useful for rough estimation of the survival period in terms of "6 mo or longer or less than 6 mo" and "1 year or longer or less than 1 year". At least, they are much more reliable than the prognosis based on a single prognostic factor.

However, which of the scoring systems is the best remains unclear. There have been few validation studies concerning the prognostic accuracy of scoring systems other than Tokuhashi's system and Tomita's system, which succeeded it. At least, all scoring systems have limitations, and there is no system by which the agreement rate between the predicted and actual survival periods is 90% or higher.

Table 12 Rades risk score for death within 2 mo after radiotherapy

Characteristic	Score(points)
ECOG performance status	
2	0
3-4	4
Tumor type	
Breast cancer	1
Prostate cancer	2
Myeloma/lymphoma	1
Lung cancer	3
Other	3
Further bone metastases	
No	1
Yes	3
Visceral metastases	
No	1
Yes	4
Interval from cancer diagnosis to MSCC	
≤ 15 mo	3
> 15 mo	1
Ambulatory status prior to RT	
Not ambulatory	4
Ambulatory before RT	1
Time of developing motor deficits	
1-7 d	4
> 7 d	1

ECOG: Eastern Cooperative Oncology Group; MSCC: Metastatic spinal cord compression; RT: Radiotherapy.

Scoring systems are practically used most frequently for the evaluation of surgical indications[25-32,45-53]. Some scoring systems were prepared to avoid selecting excessive treatments for patients with a poor prognosis[54-56]. Rades *et al*[56] (2013) examined risk factors for dying within two months after radiotherapy. As a result, for those with 24 points or more, 96.0% died within two months after radiotherapy, and the specificity was 99.8% (Table 12)[56]. Scoring systems are often important for preventing the unnecessary widening of surgical indications in particular. As cost-effectiveness has recently begun to be demanded in medical care, evaluation in this regard has also become necessary.

Moreover, because of the nature of the disease, the functional prognosis depends on the survival period. Therefore, scoring systems have also begun to be used for assessing the functional prognosis. Tang *et al*[57] (2007) used the Tokuhashi score to determine the indications of rehabilitation by admission on the basis of its correlation with the functional independence measure (FIM). In addition, Yamashita *et al*[58] (2008) and Putz *et al*[59] (2008) reported that the Tokuhashi score can also be used for the prediction of functional recovery due to its correlation with neurological recovery. Rades *et al*[60,61] also reported that the ambulatory ability after treatment can be predicted using factors related to the survival period of prognostic scoring systems.

Under these circumstances, scoring systems have begun to be applied clinically as outcome measures[62,63], but no scoring system is satisfactory regarding the validity, reliability, or responsiveness.

On the other hand, there is criticism against limiting treatment alternatives based on simple numerical indices of such scoring systems[64-66]. Gasbarrini *et al*[64,65] attached importance to the evaluation of individual patients in consideration of the sensitivity, particularly to adjuvant therapies, and proposed a treatment algorithm emphasizing the multidisciplinary selection of treatments including scoring systems. Paton *et al*[67] also proposed a therapeutic strategy taking the location level (L), mechanical instability (M), neurology (N), oncology (O), patient fitness, prognosis, and prior therapy (P) into consideration.

FUTURE SCORING SYSTEMS

Scoring systems for the prognosis of patients with metastatic spinal tumors have been prepared by frontline orthopedists and radiologists from clinical viewpoints. Many of these scoring systems were proposed when sufficient systematic treatments were not performed for metastatic spinal tumors and have been used as simple and excellent tools[68]. However, as metastatic tumors have also begun to be treated aggressively, the scoring systems have become unfit for the actual situation with the diversification of treatments. Therefore, challenges for future scoring systems need some discussion.

First, oncological viewpoints, which conventional scoring systems lacked, should be incorporated with progress in cancer treatments. They include: (1) consideration of the stage and level of the disease; (2) evaluation according to the nature of the primary cancer; (3) introduction of serum levels of prognostic markers; and (4) multidisciplinary approaches, among others.

Regarding the disease stage, metastatic spinal tumors varying from those in the asymptomatic period, those in the period of progression of spinal paralysis, to those in the terminal period must be handled due to the improvement in the metastasis-detection power, but they cannot be evaluated uniformly with a single scoring system. At least, the disease stage should be specified, and scoring systems should be prepared and used accordingly. In addition, little attention has been paid to the level of involvement, and the lack of an appropriate scoring system for the cervical spine, which is infrequently affected, has been suggested as a problem to be addressed in the future[69].

Concerning evaluation according to the nature of the primary cancer, Chen *et al*[10] and Morgen *et al*[51] (2013) reported that, in some cancer types, the prognosis of patients with spinal metastases was significantly improved during a period of 5 years due to rapid improvements in the treatment, and stressed that the improvements in the prognosis should be reflected in scoring systems. The necessity of scoring systems for different types of cancer has been discussed for some time[70-72], and the development of those for different cancer types is expected to be promoted by the accumulation of cases and systematization of treatments. In this process, it is possible to incor-

Table 13 Crnalic score for prostate cancer metastases

Prognostic factor	Score (points)
Hormone status	
Hormone native	2
Hormone refractory	0
KPS (%)	
80-100	2
≤ 70	0
Visceral metastasis	
Absent	1
Present	0
PSA (ng/mL)	
Hormone native	1
Hormone refractory	
< 200	1
≥ 200	0
Total points	Median overall survival
0-1	3 mo
2-4	16 mo
5-6	61.7 mo

KPS: Karnofsky performance score; PSA: prostate-specific antigen.

porate specific markers of particular types of cancer as prognostic factors. Crnalic *et al*[73] reported a specialized scoring system for prostate cancer metastases including prostate-specific antigen (Table 13).

Finally, attention to multidisciplinary approaches is necessary instead of preparing scoring systems on the basis of the results of, or for the selection of, a single treatment. Gregory *et al*[74] proposed that prognostic scoring systems should be changed by introducing anti-vascular endothelial growth factor. The introducti ion of such new treatments may exert favorable effects on other conventional treatments[75]. Therefore, the importance of considering multidisciplinary treatments must be stressed.

REFERENCE

1 **Tokuhashi Y**, Kawano H, Ohsaka S, Matsuzaki H, Toriyama S. [A scoring system for preoperative evaluation of the prognosis of metastatic spine tumor (a preliminary report)]. *Nihon Seikeigeka Gakkai Zasshi* 1989; **63**: 482-489 [PMID: 2794626]

2 **Tokuhashi Y**, Matsuzaki H, Toriyama S, Kawano H, Ohsaka S. Scoring system for the preoperative evaluation of metastatic spine tumor prognosis. *Spine* (Phila Pa 1976) 1990; **15**: 1110-1113 [PMID: 1702559 DOI: 10.1097/00007632-199011010-00005]

3 **Tokuhashi Y**, Matsuzaki H, Kawano H, Sano S. [The indication of operative procedure for a metastatic spine tumor: a scoring system for the preoperative evaluation of the prognosis]. *Nihon Seikeigeka Gakkai Zasshi* 1994; **68**: 379-389 [PMID: 8051465]

4 **Tokuhashi Y**, Matsuzaki H, Oda H, Oshima M, Ryu J. A revised scoring system for preoperative evaluation of metastatic spine tumor prognosis. *Spine* (Phila Pa 1976) 2005; **30**: 2186-2191 [PMID: 16205345 DOI: 10.1097/01.brs.0000180401.06919.a5]

5 **Tokuhashi Y**, Ajiro Y, Umezawa N. Outcome of treatment for spinal metastases using scoring system for preoperative evaluation of prognosis. *Spine* (Phila Pa 1976) 2009; **34**: 69-73 [PMID: 19127163 DOI: 10.1097/BRS.0b013e3181913f19]

6 **Karnofsky DA.** Clinical evaluation of anticancer drugs: Cancer chemotherapy. *Gann Monograph* 1967; **2**: 223-231

7 **Enkaua EA,** Doursounian L, Chatellier G, Mabesoone F, Aimard T, Sallant G. Vertebral metastases, a critical appreciation of the preoperative prognostic Tokuhashi score in a series of 71 cases. *Spine* 1997; **22**: 2293-2298 [DOI: 10.1097/00007632-199710010-00020]

8 **Riegel T**, Schilling T, Sitter H, Benes L, Wilke A, Gross MW, Bertalanffy H. [Analysis of factors affecting the prognosis of vertebral metastases]. *Zentralbl Neurochir* 2002; **63**: 2-6 [PMID: 12098076 DOI: 10.1055/s-2002-31578]

9 **Ulmar B**, Richter M, Cakir B, Muche R, Puhl W, Huch K. The Tokuhashi score: significant predictive value for the life expectancy of patients with breast cancer with spinal metastases. *Spine* (Phila Pa 1976) 2005; **30**: 2222-2226 [PMID: 16205351 DOI: 10.1097/01.brs.0000181055.10977.5b]

10 **Chen H**, Xiao J, Yang X, Zhang F, Yuan W. Preoperative scoring systems and prognostic factors for patients with spinal metastases from hepatocellular carcinoma. *Spine* (Phila Pa 1976) 2010; **35**: E1339-E1346 [PMID: 20938387 DOI: 10.1097/BRS.0b013e3181e574f5]

11 **Majeed H**, Kumar S, Bommireddy R, Klezl Z, Calthorpe D. Accuracy of prognostic scores in decision making and predicting outcomes in metastatic spine disease. *Ann R Coll Surg Engl* 2012; **94**: 28-33 [PMID: 22524919 DOI: b10.1308/003588412X13171221498424]

12 **Hernandez-Fernandez A**, Vélez R, Lersundi-Artamendi A, Pellisé F. External validity of the Tokuhashi score in patients with vertebral metastasis. *J Cancer Res Clin Oncol* 2012; **138**: 1493-1500 [PMID: 22526160 DOI: 10.1007/s00432-012-1222-2]

13 **Padalkar P**, Tow B. Predictors of survival in surgically treated patients of spinal metastasis. *Indian J Orthop* 2011; **45**: 307-313 [PMID: 21772622 DOI: 10.4103/0019-5413.82333]

14 **Tabouret E**, Cauvin C, Fuentes S, Esterni B, Adetchessi T, Salem N, Madroszyk A, Gonçalves A, Casalonga F, Gravis G. Reassessment of scoring systems and prognostic factors for metastatic spinal cord compression. *Spine J* 2013 Oct 9; Epub ahead of print [PMID: 24120144 DOI: 10.1016/j.spinee.2013.06.036]

15 **Yamashita T,** Siemionow KB, Mroz T, Podichetty V, Lieberman IH. A prospective analysis of prognostic factors in patients with spinal metastases: Use of the revised Tokuhashi score. *Spine* 2011; **36**: 910-917 [DOI: 10.1097/BRS.0b013e3181e56ec1]

16 **Hessler C**, Vettorazzi E, Madert J, Bokemeyer C, Panse J. 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) 2011; **36**: 983-989 [PMID: 21217434 DOI: 10.1097/BRS.0b013e3181e8f7f8]

17 **Tokuhashi Y,** Oshima M, Uei H. Letter to editor. *Spine* 2012; **37**: 429 [DOI: 10.1097/BRS.0b013e31824589be]

18 **Quraishi NA**, Manoharan SR, Arealis G, Khurana A, Elsayed S, Edwards KL, Boszczyk BM. Accuracy of the revised Tokuhashi score in predicting survival in patients with metastatic spinal cord compression (MSCC). *Eur Spine J* 2013; **22** Suppl 1: S21-S26 [PMID: 23328875 DOI: 10.1007/s00586-012-2649-5]

19 **Pointillart V**, Vital JM, Salmi R, Diallo A, Quan GM. Survival prognostic factors and clinical outcomes in patients with spinal metastases. *J Cancer Res Clin Oncol* 2011; **137**: 849-856 [PMID: 20820803 DOI: 0.1007/s00432-010-0946-0]

20 **Wang M**, Bünger CE, Li H, Wu C, Høy K, Niedermann B, Helmig P, Wang Y, Jensen AB, Schättiger K, Hansen ES. Predictive value of Tokuhashi scoring systems in spinal metastases, focusing on various primary tumor groups: evaluation of 448 patients in the Aarhus spinal metastases database. *Spine* (Phila Pa 1976) 2012; **37**: 573-582 [PMID: 21796024 DOI: 10.1097/BRS.0b013e31822bd6b0]

21 **Liang T**, Wan Y, Zou X, Peng X, Liu S. Is surgery for spine metastasis reasonable in patients older than 60 years? *Clin Orthop Relat Res* 2013; **471**: 628-639 [PMID: 23179121 DOI:

10.1007/s11999-012-2699-3]
22 **Kostuik JP.** The development of a preoperative scoring assessment system of metastatic spine disease. Proceeding of The 12th Annual Meeting of North American Spine Society; 1997 Oct 22-25; New York
23 **Tomita K**, Kawahara N, Kobayashi T, Yoshida A, Murakami H, Akamaru T. Surgical strategy for spinal metastases. *Spine* (Phila Pa 1976) 2001; **26**: 298-306 [PMID: 11224867 DOI: 10.1097/00007632-200102010-00016]
24 **Kawahara N**, Tomita K, Murakami H, Demura S. Total en bloc spondylectomy for spinal tumors: surgical techniques and related basic background. *Orthop Clin North Am* 2009; **40**: 47-63, vi [PMID: 19064055 DOI: 10.1016/j.ocl.2008.09.004]
25 **Zairi F**, Arikat A, Allaoui M, Marinho P, Assaker R. Minimally invasive decompression and stabilization for the management of thoracolumbar spine metastasis. *J Neurosurg Spine* 2012; **17**: 19-23 [PMID: 22607222 DOI: 10.3171/2012.4.SPINE111108]
26 **Walter J**, Reichart R, Waschke A, Kalff R, Ewald C. Palliative considerations in the surgical treatment of spinal metastases: evaluation of posterolateral decompression combined with posterior instrumentation. *J Cancer Res Clin Oncol* 2012; **138**: 301-310 [PMID: 22127369 DOI: 10.1007/s00432-011-1100-3]
27 **Zhang D**, Xu W, Liu T, Yin H, Yang X, Wu Z, Xiao J. Surgery and prognostic factors of patients with epidural spinal cord compression caused by hepatocellular carcinoma metastases: retrospective study of 36 patients in a single center. *Spine* (Phila Pa 1976) 2013; **38**: E1090-E1095 [PMID: 23632333 DOI: 10.1097/BRS.0b013e3182983bf8]
28 **Cho DC**, Sung JK. Palliative surgery for metastatic thoracic and lumbar tumors using posterolateral transpedicular approach with posterior instrumentation. *Surg Neurol* 2009; **71**: 424-433 [PMID: 18586305 DOI: 10.1016/j.surneu.2008.02.049]
29 **Omeis I**, Bekelis K, Gregory A, McGirt M, Sciubba D, Bydon A, Wolinsky JP, Gokaslan Z, Witham T. The use of expandable cages in patients undergoing multilevel corpectomies for metastatic tumors in the cervical spine. *Orthopedics* 2010; **33**: 87-92 [PMID: 20192145 DOI: 10.3928/01477447-20100104-12]
30 **Sundaresan N**, Rothman A, Manhart K, Kelliher K. Surgery for solitary metastases of the spine: rationale and results of treatment. *Spine* (Phila Pa 1976) 2002; **27**: 1802-1806 [PMID: 12195075 DOI: 10.1097/00007632-200208150-00021]
31 **Chi JH**, Gokaslan Z, McCormick P, Tibbs PA, Kryscio RJ, Patchell RA. Selecting treatment for patients with malignant epidural spinal cord compression-does age matter?: results from a randomized clinical trial. *Spine* (Phila Pa 1976) 2009; **34**: 431-435 [PMID: 19212272 DOI: 10.1097/BRS.0b013e318193a25b]
32 **Hu Y**, Xia Q, Ji J, Miao J. One-stage combined posterior and anterior approaches for excising thoracolumbar and lumbar tumors: surgical and oncological outcomes. *Spine* (Phila Pa 1976) 2010; **35**: 590-595 [PMID: 20118840 DOI: 10.1097/BRS.0b013e3181b967ca]
33 **Bauer H**, Tomita K, Kawahara N, Abdel-Wanis ME, Murakami H. Surgical strategy for spinal metastases. *Spine* (Phila Pa 1976) 2002; **27**: 1124-1126 [PMID: 12004183 DOI: 10.1097/00007632-200205150-00027]
34 **Bauer HC**, Wedin R. Survival after surgery for spinal and extremity metastases. Prognostication in 241 patients. *Acta Orthop Scand* 1995; **66**: 143-146 [PMID: 7740944]
35 **Leithner A**, Radl R, Gruber G, Hochegger M, Leithner K, Welkerling H, Rehak P, Windhager R. Predictive value of seven preoperative prognostic scoring systems for spinal metastases. *Eur Spine J* 2008; **17**: 1488-1495 [PMID: 18787846 DOI: 10.1007/s00586-008-0763-1]
36 **Wibmer C**, Leithner A, Hofmann G, Clar H, Kapitan M, Berghold A, Windhager R. Survival analysis of 254 patients after manifestation of spinal metastases: evaluation of seven preoperative scoring systems. *Spine* (Phila Pa 1976) 2011; **36**: 1977-1986 [PMID: 21304424 DOI: 10.1097/BRS.0b013e3182011f84]
37 **van der Linden YM**, Dijkstra SP, Vonk EJ, Marijnen CA, Leer JW. Prediction of survival in patients with metastases in the spinal column: results based on a randomized trial of radiotherapy. *Cancer* 2005; **103**: 320-328 [PMID: 15593360 DOI: 10.1002/cncr.20756]
38 **Rades D**, Dunst J, Schild SE. The first score predicting overall survival in patients with metastatic spinal cord compression. *Cancer* 2008; **112**: 157-161 [PMID: 17948910 DOI: 10.1002/cncr.23150]
39 **Rades D**, Douglas S, Veninga T, Stalpers LJ, Hoskin PJ, Bajrovic A, Adamietz IA, Basic H, Dunst J, Schild SE. Validation and simplification of a score predicting survival in patients irradiated for metastatic spinal cord compression. *Cancer* 2010; **116**: 3670-3673 [PMID: 20564129 DOI: 10.1002/cncr.25223]
40 **Rades D**, Douglas S, Veninga T, Bajrovic A, Stalpers LJ, Hoskin PJ, Rudat V, Schild SE. A survival score for patients with metastatic spinal cord compression from prostate cancer. *Strahlenther Onkol* 2012; **188**: 802-806 [PMID: 22526228 DOI: 10.1007/s00066-012-0106-3]
41 **Rades D**, Douglas S, Schild SE. A validated survival score for breast cancer patients with metastatic spinal cord compression. *Strahlenther Onkol* 2013; **189**: 41-46 [PMID: 23138773 DOI: 10.1007/s00066-012-0230-0]
42 **Douglas S**, Schild SE, Rades D. Metastatic spinal cord compression in patients with cancer of unknown primary. Estimating the survival prognosis with a validated score. *Strahlenther Onkol* 2012; **188**: 1048-1051 [PMID: 23053138 DOI: 10.1007/s00066-012-0130-3]
43 **Katagiri H,** Takahashi M, Wakai K, Sugiura H, Kataoka T, Nakanishi K. Prognostic factors and a scoring system for patients with skeletal metastasis. *J Bone Joint Surg Br* 2005; **87**: 698-703[DOI: 10.1302/0301-620X.87B5.15185]
44 **Kawai T,** Aota Y, Yamashita T, Ono M, Mroz TE, Liberman IH, Saito T. Analysis of survival prognostic factors in patients with newly detected metastatic spinal tumors. *J Spine Res* 2013; **4**: 136-142
45 **Rompe JD**, Hopf CG, Eysel P. Outcome after palliative posterior surgery for metastatic disease of the spine--evaluation of 106 consecutive patients after decompression and stabilisation with the Cotrel-Dubousset instrumentation. *Arch Orthop Trauma Surg* 1999; **119**: 394-400 [PMID: 10613227 DOI: 10.1007/s004020050008]
46 **Chataigner H**, Onimus M. Surgery in spinal metastasis without spinal cord compression: indications and strategy related to the risk of recurrence. *Eur Spine J* 2000; **9**: 523-527 [PMID: 11189921 DOI: 10.1007/s005860000163]
47 **Ernstberger T**, Kögel M, König F, Schultz W. Expandable vertebral body replacement in patients with thoracolumbar spine tumors. *Arch Orthop Trauma Surg* 2005; **125**: 660-669 [PMID: 16215720 DOI: 10.1007/s00402-005-0057-6]
48 **Melcher I**, Disch AC, Khodadadyan-Klostermann C, Tohtz S, Smolny M, Stöckle U, Haas NP, Schaser KD. Primary malignant bone tumors and solitary metastases of the thoracolumbar spine: results by management with total en bloc spondylectomy. *Eur Spine J* 2007; **16**: 1193-1202 [PMID: 17252218 DOI: 10.1007/s00586-006-0295-5]
49 **Abel R**, Keil M, Schläger E, Akbar M. Posterior decompression and stabilization for metastatic compression of the thoracic spinal cord: is this procedure still state of the art? *Spinal Cord* 2008; **46**: 595-602 [PMID: 18317487 DOI: 10.1038/sc.2008.11]
50 **Biermann JS**, Holt GE, Lewis VO, Schwartz HS, Yaszemski MJ. Metastatic bone disease: diagnosis, evaluation, and treatment. *Instr Course Lect* 2010; **59**: 593-606 [PMID: 20415408]
51 **Morgen SS**, Lund-Andersen C, Larsen CF, Engelholm

SA, Dahl B. Prognosis in patients with symptomatic metastatic spinal cord compression: survival in different cancer diagnosis in a cohort of 2321 patients. *Spine* (Phila Pa 1976) 2013; **38**: 1362-1367 [PMID: 23574811 DOI: 10.1097/BRS.0b013e318294835b]

52 **Kim HJ**, Buchowski JM, Moussallem CD, Rose PS. Modern techniques in the treatment of patients with metastatic spine disease. *Instr Course Lect* 2013; **62**: 375-382 [PMID: 23395042]

53 **Druschel C**, Disch AC, Melcher I, Luzzati A, Haas NP, Schaser KD. [Multisegmental en bloc spondylectomy. Indications, staging and surgical technique]. *Oper Orthop Traumatol* 2012; **24**: 272-283 [PMID: 22743631 DOI: 10.1007/s00064-011-0070-6]

54 **Tancioni F**, Navarria P, Lorenzetti MA, Pedrazzoli P, Masci G, Mancosu P, Alloisio M, Morenghi E, Santoro A, Rodriguez y Baena R, Scorsetti M. Multimodal approach to the management of metastatic epidural spinal cord compression (MESCC) due to solid tumors. *Int J Radiat Oncol Biol Phys* 2010; **78**: 1467-1473 [PMID: 20231072 DOI: 10.1016/j.ijrobp.2009.09.038]

55 **Tancioni F**, Navarria P, Pessina F, Attuati L, Mancosu P, Alloisio M, Scorsetti M, Santoro A, Baena RR. 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* 2012; **21** Suppl 1: S146-S148 [PMID: 22407265 DOI: 10.1007/s00586-012-2232-0]

56 **Rades D**, Hueppe M, Schild SE. A score to identify patients with metastatic spinal cord compression who may be candidates for best supportive care. *Cancer* 2013; **119**: 897-903 [PMID: 23065671 DOI: 10.1002/cncr.27849]

57 **Tang V**, Harvey D, Park Dorsay J, Jiang S, Rathbone MP. Prognostic indicators in metastatic spinal cord compression: using functional independence measure and Tokuhashi scale to optimize rehabilitation planning. *Spinal Cord* 2007; **45**: 671-677 [PMID: 17228353 DOI: 10.1038/sj.sc.3102024]

58 **Yamashita T**, Aota Y, Kushida K, Murayama H, Hiruma T, Takeyama M, Iwamura Y, Saito T. Changes in physical function after palliative surgery for metastatic spinal tumor: association of the revised Tokuhashi score with neurologic recovery. *Spine* (Phila Pa 1976) 2008; **33**: 2341-2346 [PMID: 18827700 DOI: 10.1097/BRS.0b013e3181878733]

59 **Putz C**, Wiedenhöfer B, Gerner HJ, Fürstenberg CH. Tokuhashi prognosis score: an important tool in prediction of the neurological outcome in metastatic spinal cord compression: a retrospective clinical study. *Spine* (Phila Pa 1976) 2008; **33**: 2669-2674 [PMID: 18981960 DOI: 10.1097/BRS.0b013e318188b98f]

60 **Rades D**, Rudat V, Veninga T, Stalpers LJ, Basic H, Karstens JH, Hoskin PJ, Schild SE. A score predicting posttreatment ambulatory status in patients irradiated for metastatic spinal cord compression. *Int J Radiat Oncol Biol Phys* 2008; **72**: 905-908 [PMID: 18436390 DOI: 10.1016/j.ijrobp.2008.02.018]

61 **Rades D**, Douglas S, Huttenlocher S, Rudat V, Veninga T, Stalpers LJ, Basic H, Karstens JH, Hoskin PJ, Adamietz IA, Schild SE. Validation of a score predicting posttreatment ambulatory status after radiotherapy for metastatic spinal cord compression. *Int J Radiat Oncol Biol Phys* 2011; **79**: 1503-1506 [PMID: 20605351 DOI: 10.1016/j.ijrobp.2010.01.024]

62 **North RB**, LaRocca VR, Schwartz J, North CA, Zahurak M, Davis RF, McAfee PC. Surgical management of spinal metastases: analysis of prognostic factors during a 10-year experience. *J Neurosurg Spine* 2005; **2**: 564-573 [PMID: 15945430 DOI: 10.3171/spi.2005.2.5.0564]

63 **Quraishi NA,** Manoharan SR, Arealis G, Boszczyk BM. Thirty days mortality rate in the surgical treatment of patients with metastatic spinal cord compression. *Spine J* 2013; **7**: 193

64 **Gasbarrini A**, Cappuccio M, Mirabile L, Bandiera S, Terzi S, Barbanti Bròdano G, Boriani S. Spinal metastases: treatment evaluation algorithm. *Eur Rev Med Pharmacol Sci* 2004; **8**: 265-274 [PMID: 15745386]

65 **Gasbarrini A,** Li H, Cappuccio M, Mirabile L, Paderni S, Terzi S, Boriani S. Efficacy evaluation of a new treatment algorithm for spinal metastases. *Spine* 2010; **35**: 1466-1470

66 **Sun YQ**, Cai YB, Rong GW. [Comparison of evaluating system for patients with spinal metastases]. *Zhonghua Waike Zazhi* 2003; **41**: 570-574 [PMID: 14505527]

67 **Paton GR**, Frangou E, Fourney DR. Contemporary treatment strategy for spinal metastasis: the "LMNOP" system. *Can J Neurol Sci* 2011; **38**: 396-403 [PMID: 21515496]

68 **Tokuhashi Y**, Ajiro Y, Oshima M. Algorithms and planning in metastatic spine tumors. *Orthop Clin North Am* 2009; **40**: 37-46, v-vi [PMID: 19064054 DOI: 10.1016/j.ocl.2008.09.002]

69 **Cho W**, Chang UK. Neurological and survival outcomes after surgical management of subaxial cervical spine metastases. *Spine* (Phila Pa 1976) 2012; **37**: E969-E977 [PMID: 22343276 DOI: 10.1097/BRS.0b013e31824ee1c2]

70 **Ogihara S**, Seichi A, Hozumi T, Oka H, Ieki R, Nakamura K, Kondoh T. Prognostic factors for patients with spinal metastases from lung cancer. *Spine* (Phila Pa 1976) 2006; **31**: 1585-1590 [PMID: 16778693 DOI: 10.1097/01.brs.0000222146.91398.c9]

71 **Shehadi JA**, Sciubba DM, Suk I, Suki D, Maldaun MV, McCutcheon IE, Nader R, Theriault R, Rhines LD, Gokaslan ZL. Surgical treatment strategies and outcome in patients with breast cancer metastatic to the spine: a review of 87 patients. *Eur Spine J* 2007; **16**: 1179-1192 [PMID: 17406908 DOI: 10.1007/s00586-007-0357-3]

72 **Williams BJ**, Fox BD, Sciubba DM, Suki D, Tu SM, Kuban D, Gokaslan ZL, Rhines LD, Rao G. Surgical management of prostate cancer metastatic to the spine. *J Neurosurg Spine* 2009; **10**: 414-422 [PMID: 19442002 DOI: 10.3171/2009.1]

73 **Crnalic S**, Löfvenberg R, Bergh A, Widmark A, Hildingsson C. Predicting survival for surgery of metastatic spinal cord compression in prostate cancer: a new score. *Spine* (Phila Pa 1976) 2012; **37**: 2168-2176 [PMID: 22648028 DOI: 10.1097/BRS.0b013e31826011bc]

74 **Gregory TM,** Coriat R, Mir O. Prognostic scoring systems for spinal metastases in the era of anti-VEGF therapies. *Spine* 2013; **38**: 965-966 [DOI: 10.1097/BRS.0b013e3182609d38]

75 **Chong S,** Shin SH, Yoo H, Lee SH, Kim KJ, Jahng TA, Gwak HS. Single-stage posterior decompression and stabilization for metastasis of the thoracic spine: prognostic factors for functional outcome and patients' survival. *Spine J* 2012; **12**: 1083-1092 [DOI: 10.1016/j.spinee.2012.10.015]

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