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TREATMENT OPTIONS AND SURGICAL INDICATIONS IN SPINAL METASTASIS CASES: SINS AND NOMS CLASSIFICATIONS

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ABSTRACT

Objective: Spinal metastases are the most common tumors of the spine, constituting approximately 90% of masses encountered on spinal imaging. Spinal metastases are more commonly found as bone metastases, but are not limited to bone metastases, and approximately 20% present with symptoms of spinal canal invasion and cord compression.

Materials and Methods: A total of 32 patients who were operated for spinal bone metastases in our clinic between April 2020 and April 2022 were examined retrospectively with digital file records and imaging.

Results: Of the 32 patients included in our study, 5 (15.6%) were operated for cervical, 21 (65.6%) for thoracic, 8 (25%) for lumbar, 2 (6.25%) for sacral spinal bone metastases. There were multiple metastases in 7 (21.8%) patients. Twenty of the patients (62.5%) were male and 12 (37.5%) were female. The mean age was 67.3±13.8 years. According to the Tomita scoring, the mean was 4,8 (minimum 2-maximum 7). When the Frankel scoring of the patients was performed, 6 (18.75%) patients were B grade, 1 (3.1%) patient was C grade, and 25 (78.1%) patients were E grade. Patients with a Spinal Instability Neoplastic Score (SINS) value above 7 were considered suitable for surgery. In our study, the mean SINS was 11.1 (minimum 7, maximum 17). All patients were evaluated according to the neurologic, oncologic, mechanical, and systemic (NOMS) framework. Patients who were not suitable for surgery according to the NOMS evaluation were referred for radiotherapy/chemotherapy and weren't included in the study.

Conclusion: The decision-making process is difficult in patients with metastatic spinal disease. The surgeon must take into consider the purpose of the intended surgery (to counteract pain and preserve or restore neurological function) and the physical ability of each patient to withstand such a surgery.

Keywords: SINS, Frankel scale, spinal metastasis, tomita classification, multidisciplinary approach, NOMS

INTRODUCTION

Bone metastases are a prevalent disease, including lung, breast, prostate, kidney, and some thyroid cancers, as well as hematological malignancies especially multiple myeloma that can be considered generating tumors. About 10-15% of cancer patients have metastases to the spine[1]. Spinal bone metastases are seen in approximately 5% of cancer cases diagnosed each year. The skeletal system is the third most familiar site of metastasis, it is coming after lung and liver metastasis. Likewise, the spine is a familiar region for metastases, throughout the skeletal system. The thoracic part is the most common region within the spine. While the vertebral body is comprised of 80-85% of metastases, the posterior elements are comprised of 20-25%. The most common primary source of metastatic tumors of the spine is breast cancer. After that; lung cancer, prostate cancer, and hematological malignancies follow breast cancer. Of all tumors, multiple myeloma has the highest proclivity for spinal metastases. Various sarcoma and neuroblastoma metastases are more common in children[2].

Spine metastases can cause a vertebra to weaken or fracture. The tumor may enlarge or cause the vertebra to fracture, causing compression of the spinal cord or nerve root. Patients with spinal cord compression (SpCC) are at risk for paralysis of body structures below the compression level, weakness in limb movement, urinary/fecal incontinence, and impaired sexual function. Early targeted therapy is to prevent, reduce or delay serious adverse outcomes. Diagnostic imaging methods comprise plain radiography, computed tomography (CT), magnetic resonance imaging (MRI), positron emission tomography, single photon emission CT and radionuclide bone scan.

Together with cancer histology, neurological status, and overall survival, patient characteristics such as Karnofsky score, other medical comorbidities, and nutritional status should be

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conceived not only when making an operation decision, but also in selecting the proper surgical procedure. The goals of treatment of spinal bone metastatic lesions are to inhibit neurologic regression, relieve pain, reestablish neurologic status, and stabilize ranges of motion of the spine. Generally, palliation and improving quality of life are the goals. However, there is uncertainty about the effectiveness of these treatment modalities.

MATERIALS AND METHODS

A total of 32 patients who were operated on for spinal bone metastases in our clinic between April 2020 and April 2022 were examined retrospectively with digital file records and imaging. This study was approved by the Ankara City Hospital Clinical Research Ethics Committee (decision no: E1/2948/2022, date no: 05.10.2022), and written informed consent was obtained for each patient. All patients underwent MRI and/or CT scanning preoperatively and postoperatively. Advanced imaging methods were used in all patients with ambiguous metastatic lesions. Data such as pathology, surgical approach, clinical features, demographic variables, and location were analyzed retrospectively. The neurological status of the patients was evaluated using the Frankel grading system. Frankel A, B, and C were considered "Poor", and Frankel D and E's neurological status was considered "Good".

Spinal Instability Neoplastic Score (SINS) was also evaluated in patients. The SINS eventuates of 6 components. These components are the level of the metastatic spinal bone lesion, the characteristic of the metastasis (lytic or blastic), spinal alignment, the extent of vertebral body collapse, the existence of mechanical pain, and involvement of the posterolateral elements. The sum of these parameters results in an overall score between 0 and 18 divided into 3 spinal stability categories. 0-6 points constitute the stable group, 7-12 points the potential spinal instability group, and 13-18 points the unstable spinal lesion group[3]. Patients with a SINS score of ⩾7 are candidates for surgical intervention. Spinal instability is thought to be related to higher pain scores and more remarkable deterioration in physical function stated by the patient[4] (Table 1).

Neurologic, oncologic, mechanical, and systemic (NOMS) is a classification system that combines four basic evaluations: Neurological, oncological, systemic disease, and mechanical instability. The purpose of NOMS that to determine the use of systemic therapy, surgery, and/or radiation for the treatment of spinal metastases. Additionally, NOMS obtain health workers with a common language across disciplines to support select treatment plans for each patient and encourage outcome analysis between institutions[5] (Table 2).

Neurological assessment in NOMS is an assessment of the functional radiculopathy, myelopathy, and degree of epidural SpCC. Oncological assessment is based on the expected tumor response and continuity of response to current treatment modalities such as surgery, immunotherapy, conventional external beam radiation therapy, chemotherapy, stereotactic radiosurgery, or hormones. Mechanical instability is another issue described for pathological fractures; treatment options include pedicle screw, percutaneous cement application, brace application, and/or decompression surgery. The 4th evaluation is the medical comorbidities, the extent of systemic disease, assessment of the patient's ability to tolerate a recommended therapy, and expected overall patient survival relying on the extent of metastatic spinal bone lesions and tumor histology[5]. Tomita et al.[6] compiled the results of patients with spinal bone metastases who had surgical interventions and presented a classification. They designed a 10 point scale that takes into consideration the extent of bone metastases and tumor histology. The scale aims to determine the purpose of the treatment and thus the aggressiveness of the surgery. In the report, the treatment goal of patients with rapidly growing tumors and systemic metastases, such as lung or stomach, is terminal care or mostly short-term palliation; therefore these patients are suitable for supportive care or limited palliative decompression surgery, solely. Nonetheless, patients with solitary spinal metastases and slow-growing tumors such as breast or thyroid cancers are nominees for extensive or marginal excision of the spinal bone metastasis tumor for long-term control[6]. In our study, we classified the patients according to the Tomita score.

Statistical Analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences version 13.0 for Windows (SPSS Inc., Chicago, IL). Continuous variables were compared with the t-test and categorical variables were compared with the chi-square test. A p-value of <0.05 was considered statistically significant.

RESULTS

Of the 32 patients included in our study, 5 (15.6%) were operated on for cervical, 21 (65.6%) for thoracic, 8 (25%) for lumbar, and 2 (6.25%) for sacral spinal bone metastases. There were multiple metastases in 7 (21.8%) patients. Twenty of the patients (62.5%) were male and 12 (37.5%) were female. The mean age was 67.3±13.8 years. According to the Tomita scoring, the mean was 4.8 (minimum 2 - maximum 7). When the initial complaints of the patients were examined, 8 (25%) were found to have weakness in the extremities, 16 (50%) had vertebral pain, and 6 (18.75%) had no active complaints, but cancer was detected during screening. When the Frankel scoring of the patients was performed, 6 (18.75%) patients were B grade, 1 (3.1%) patient was C grade, and 25 (78.1%) patients were E grade. When the post-op neurological examination was evaluated, the neurological examination of the patient with Frankel grade C did not change, while the deficits of two patients with grade B increased and became grade A. There was some improvement in the deficits of the other 4 patients

Table 1. Spinal Instability Neoplastic Score

		Score
Location	Junctional (occiput-C2, C7-T2, T11-L1, L5-s1)	3
	Mobile spine (C3-6, L2-4)	2
	Semirigid (T3-T10)	1
	Rigid (S2-S5)	0
Pain	Yes	3
	Occasional pain but not mechanical	1
	Pain-free lesion	0
Bone lesion	Lytic	2
	Mixed (lytic/blastic)	1
	Blastic	0
Radiographic spinal alignment	Subluxation/translation present	4
	De novo deformity (kyphosis/scoliosis)	2
	Normal alignment	0
Vertebral body collapse	>50%	3
	<50%	2
	No collapse with >50% body involved	1
	None of the above	0
Posterolateral involvement of spinal elements	Bilateral	3
	Unilateral	1
	None of the above	0
Total score	Stable	0-6
	Indeterminate	7-12
	Unstable	13-18

Table 2. Neurologic, oncologic, mechanical, and systemic decision framework

Neurologic	Oncologic	Mechanical	Systemic	Decision
Low-grade ESCC + no myelopathy	Radiosensitive	Stable		cEBRT
	Radiosensitive	Unstable		Stabilization followed by cEBRT
	Radioresistant	Stable		SRS
	Radioresistant	Unstable		Stabilization followed by SRS
High-grade ESCC ± myelopathy	Radiosensitive	Stable		cEBRT
	Radiosensitive	Unstable		Stabilization followed by cEBRT
	Radioresistant	Stable	Able to tolerate surgery	Decompression/stabilization followed by SRS
	Radioresistant	Stable	Unable to tolerate surgery	cEBRT
	Radioresistant	Unstable	Able to tolerate surgery	Decompression/stabilization followed by SRS
	Radioresistant	Unstable	Unable to tolerate surgery	Stabilization followed by cEBRT

Stabilization options include percutaneous cement augmentation, percutaneous pedicle screw instrumentation, and open surgery.
ESCC: Epidural spinal cord compression scale (grade 0-1= low-grade, grade 2-3= high-grade), cEBRT: Conventional external beam radiation, SRS: Stereotactic radiosurgery

with grade B, which was evaluated as grade C. There was no change in patients with Frankel classification grade E. Six of the patients (18.75%) had a history of previously diagnosed cancer. Pathology was determined as lung cancer in 11 (34.3%) patients (such as squamous cell, small cell, adenocarcinoma), pathology in 7 (21.8%) patients as breast cancer, pathology in 1 (3.1%) patient as prostate cancer, pathology in 1 (3.1%) patient as multiple myeloma, and pathology as lymphoma in 12 (37.5%) patients (Table 3).

Patients with a SINS value above 7 were considered suitable for surgery. In our study, the mean SINS was 11.1 (minimum 7, maximum 17). All patients were evaluated according to the NOMS framework. Patients who were not suitable for surgery according to the NOMS evaluation were referred for

Table 3. Patient characteristics and clinical presentations

		n	%
Sex	Male	20	62.5
	Female	12	37.5
Age (years)*		67.3±13.8	69 (44-77)
Localisation	Cervical	5	15.6
	Thoracic	21	65.6
	Lumbar	8	25
	Sacral	2	6.25
	Multiple	7	21.8
Tomita score		4.8 (minimum 2, maximum 7)	
Frankel scale (preop-postop)	Grade A	0-2	0-6.25
	Grade B	6-0	18.75-0
	Grade C	1-5	3.1-15.6
	Grade D	0-0	0-0
	Grade E	25-25	78.1-78.1
Pathology	Lung	11	34.3
	Breast	7	21.8
	Prostate	1	3.1
	Multiple myeloma	1	3.1
	Lymphoma	12	37.5
Spinal Instability Neoplastic Score		11.1 (minimum 7, maximum 17)	

*Mean ± standard deviation/median (minimum - maximum)

radiotherapy/chemotherapy and were not included in the study. Data analysis was performed using IBM SPSS 26.0 (Armonk, NY: IBM Corp.) statistical analysis program. Descriptive statistical methods (frequency, percentage, mean, standard deviation, median, minimum – maximum, etc.) were used to compare data.

DISCUSSION

The most common route of spread to the spine is hematogenous spread. The main reason for this spread is the paravertebral plexus (Batson's plexus), which does not have a valve structure. Afterward, the tumor spreads to other spines with tumor embolism[7]. This usually causes patients to have multiple involvements. In addition, the reflection of venous blood return to intervertebral veins because of increased intrathoracic and intra-abdominal pressure also strengthens multiple metastases. Consequently, spinal bone metastases following this metabolic pathway cause a specific pattern of bone spread. Because of its avascular nature, the intervertebral disc is generally spared from tumor involvement: After all, the more often and seriously involved part of the vertebra is the vertebral body (approximately 80-85%), followed by lateral and posterior elements such as pedicle, lamina, etc. These reasons explain why most spinal bone metastases are located anterior to the spinal cord or dural sac, resulting in an anterior epidural compression[8,9]. Most spinal bone metastases' locations are extradural. In addition, only 5% of spinal bone metastases are intradural and less than 1% are intramedullary[9].

The clinical characteristics of spinal bone metastasis are mainly progressive deformity, neurological deficit, pain, and symptoms related to tumor origin. Pain may be localized to a specific structure and level of the spine or radicular pain. The pain may be due to bone involvement, instability caused by metastasis, or compression of neuronal tissues. The spectrum of pain is quite wide. It is stated that the pain is constant and dull, but predominant at night and is generally not affected by the arrangement of physical activities. In general, progressive, dull pain that occurs in a patient with known cancer or may become more pronounced in the elderly is suggestive of spinal metastasis[10,11].

Since most metastatic lesions begin in the vertebral body, anterior SpCC can be anticipated. Therefore, spastic paraparesis occurs clinically, which might eventually end up paresis[12,13]. Usually, this paraparesis is followed by sensory deterioration. It may proceed slowly, but it always has the potential to deteriorate within days. In the advanced stage of compression; bladder paresis, sphincter dysfunction, and sensory impairments are observed. Bladder paresis and sphincter dysfunction are generally irreversible if it persists for more than 48 hours[12-14].

For the treatment of metastatic spine tumors, SINS is an ideal classification for the detection of surgical options. NOMS is a broader treatment evaluation system. While minimizing treatment-related morbidity with this classification, it should emphasize durable tumor control by considering effective pharmacological, surgical, and radiation treatment options to approach this goal. NOMS ensures a framework that enables decision-making and can optimize patient care and treatment.

The therapeutic decision in elderly patients with spinal metastases is particularly difficult when they have remarkable comorbidities alongside metastatic disease. Nowadays, there are mainly four treatment modalities after steroid administration. These modalities are radiation, surgery, bisphosphonates, and, rarely, chemotherapy[15,16]. Another possibility is a combination of all of the above. Factors such as therapeutic control of the primary tumor, tumor stage, histological tumor type, and tumor dissemination are the main factors that determine the effectiveness of treatment modalities and the overall survival of patients. The life expectancy in this category of patients is approximately 12 months.

SpCC is not the only indication for treatment, but also by evaluating the main parameters of quality of life such as pain, mobility, and motor deficit. Perhaps the most important criterion when planning surgery for the patient is the patient's general condition is good enough to allow surgery safely. In addition, the patient's life expectancy of more than 6 months is another criterion for the indication of surgery. The latter, increasingly, the 6 month rule may be exceeded depending on the type of surgical treatment options that must be selected. Minimal invasive surgical approaches that result in faster recovery and less surgical trauma can be applied to these patients. In our study, we evaluated these criteria while making the surgical decision. Many of the criteria used for surgery cannot be treated rigidly and must be evaluated in an interdisciplinary decision-making process.

Study Limitations

In our study, there were certain limitations. First, this study was constituted in a retrospective manner. All patients were selected from patients suitable for surgery according to the NOMS framework, SINS classification, and Tomita classification. More studies with different designs and comparisons of the selective group with a non-selective group.

CONCLUSION

Patient factors such as performance/nutritional status and medical comorbidities should be considered, as well as cancer histology and life expectancy, to decide whether surgery is appropriate and to select the appropriate surgical procedure and approach. SINS and NOMS are valuable classifications for determining appropriate approaches.

Ethics

Ethics Committee Approval: This study was approved by the Ankara City Hospital Clinical Research Ethics Committee (decision no: E1/2948/2022, date no: 05.10.2022).

Informed Consent: Written informed consent was obtained from all patients for the publication of this report and accompanying images.

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Authorship Contributions

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