Impact of a Specialized Outpatient Clinic on Bone Metastasis and Its Burden on Spine Surgeons

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Abstract. *Background/Aim:* It is important to perform early intervention on bone metastases using multidisciplinary approaches, however it is difficult to hold frequent meetings between patients and clinicians. We aimed to evaluate the usefulness of a specialized outpatient clinic on bone metastasis, instead of the multidisciplinary approach currently in practice. *Patients and Methods:* We included 31 patients with vertebral metastases of various carcinomas, undergoing surgical treatment by spine surgeons. We divided the patients into two groups before and after their visit to the specialized outpatient clinic (pre and post groups), and compared their clinical characteristics. *Results:* The post group demonstrated a longer period from consulting the spine surgeon to the surgery than the pre group ($p=0.0129$). A multivariate logistic regression analysis revealed that the period from spine surgeon consultation to surgery was significantly associated with a specialized outpatient clinic visit ($p=0.0460$). *Conclusion:* Specialized outpatient clinics on bone metastasis could possibly reduce the burden on spinal surgeons.

Advances in drug therapies, such as molecular-targeted drugs and immune checkpoint inhibitors, have improved the prognosis of patients with advanced cancer in recent years (1). The bone is one of the most common metastatic sites. Furthermore, the number of patients with bone metastasis is likely to increase with the prognosis of cancer. The most frequent site of metastases in the bone is the spine, and 60-70% of patients with advanced cancer develop spinal

metastases during disease progression (2). Fracture-related pain and paralysis because of an extension to the spinal cord greatly impair the activity of daily life (ADL) and quality of life, and should be monitored in patients with spinal metastases. In particular, paralysis severely impairs the ADL, often necessitating emergency surgery by a spine surgeon. Moreover, emergency surgery on such patients increases the burden of the spine surgeon. The expected increase in the number of patients with bone metastases warrants measures to reduce spinal metastases-associated complications.

In recent years, researchers have reported on the need for a multidisciplinary approach by diverse professionals, such as orthopedic surgeons, oncologists, and radiologists. It is important to perform early intervention, such as radiotherapy, by sharing information on bone metastatic lesions using a multidisciplinary approach (3-11). Furthermore, a cancer board focusing on the management of bone metastases has been organized in Japan. It not only involves doctors but also nurses, physical therapists, occupational therapists, and medical social workers to achieve a multidisciplinary approach (8). However, few studies have statistically examined the effectiveness of a multidisciplinary approach for bone metastases. Furthermore, all past reports have focused on radiotherapy, and there are no reports on the surgical treatment for spinal metastases. In addition, it is difficult to hold frequent meetings because a multidisciplinary approach requires the participation and cooperation of numerous professionals. Therefore, instead of the multidisciplinary approach, we decided to open a specialized outpatient clinic on bone metastasis.

Thus, we aimed to analyze the usefulness of a specialized outpatient clinic on bone metastasis, which was initiated instead of the multidisciplinary approach, and to examine its impact on the burden on spine surgeons.

Patients and Methods

Subjects. This retrospective study enrolled patients with vertebral metastasis of carcinoma, diagnosed and surgically treated by spine surgeons at our hospital between May 2017 and April 2021. All patients who received radiotherapy for vertebral metastasis before

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Key Words: Outpatient clinic, bone metastasis, spine surgeon, multidisciplinary approach.

surgery or had brain-derived neurological deficit that affected their gait function were excluded. We eventually included 31 patients with vertebral metastasis, undergoing surgical treatment (16 men and 15 women, mean age: 67.3 years, and range=42-83 years). We inspected the patient records to collect information on their regarding age, sex, the location of the primary tumor, the site of spinal lesion, a history of primary tumor treatment, paralysis or bladder and rectal disorder, a history of denosumab treatment, the period from spine surgeon consultation to surgery, surgical method, surgery time, operation room leaving time, intraoperative bleeding volume, and preoperative embolization. The severity of the neurological deficit was assessed before the surgery using the Frankel classification (12). The specialized outpatient clinic on bone metastasis was initiated at our hospital in May 2019. We divided the patients into two groups, namely 2 years until April 2019 (Pre group) and 2 years after May 2019 (Post group). Moreover, we compared the clinical characteristics and information on surgery between the groups. In addition, we excluded patients who had not been treated for original carcinoma at our hospital or those not diagnosed with the primary tumor. We compared only patients who were being treated for primary tumors at our hospital. Furthermore, we examined factors that affected the period from consulting the spine surgeon to the surgery, in addition to those that delayed leaving the operating room.

Specialized outpatient clinic on metastatic bone tumors. From May 2019, we inaugurated a specialized outpatient clinic on bone metastasis at our hospital. One doctor with specialist qualifications in orthopedic surgery and bone and soft tissue tumor conducted session at the clinic for approximately 2 h, once a week. It primarily targeted patients being treated for carcinoma at our hospital. One patient with confirmed bone metastasis was actively introduced from other departments to the clinic. Those with a risk of fracture and spinal cord injury were regularly examined. If the doctor identified the need of consultation from the spinal surgeon for surgical adaptation, we requested for an examination to the spine surgeon. There were an average of 22.1 patients per month (range=3-41 patients) from May 2019 to April 2021.

Statistical analyses. All continuous variables are expressed as means±standard deviations (SD). We conducted Student's *t*-tests, Welch *t*-tests, and Chi Squared (χ^2) tests to compare the characteristics between the groups. A multivariate logistic regression analysis was performed to examine the factors that affected the period from spine surgeon consultation to the surgery, and those that delayed leaving the operating room. The waiting period till the surgery was defined short if the latter was performed within 4 days after the first visit of the spinal surgeon. In addition, the leaving time was defined slow if the patients left the operating room after 20:00. A *p*-value <0.05 was considered statistically significant.

Ethics. Our experiment was in accordance with the ethical standards of the Helsinki Declaration of 1975, as revised in 1983. This study was approved by the Institutional Review Board for Clinical Research at Akita University (approval number: 2658), and informed consent was obtained from all patients.

Results

Table I summarizes the clinicodemographic characteristics of the patients. Eighteen patients were treated for primary tumors at our hospital. The sites of the primary lesions were, namely

lung (n=6), breast (n=4), renal (n=4), prostate (n=4), bladder (n=2), thyroid (n=2), multiple myeloma (n=2), hypopharynx (n=2), esophagus (n=1), plasma cytoma (n=1), uterus (n=1), malignant lymphoma (n=1), and unknown (n=1). The cervical spine, thoracic spine, and lumbar spine required surgical treatment in four, 21, and six cases, respectively. The surgical procedures comprised 21, five, three, and two cases of posterior spinal fusion and decompression, posterior spinal fusion, percutaneous pedicle screw, and posterior decompression, respectively. The mean period from spine surgeon consultation to the surgery for all patients was 9.3±10.6 days (range=0-46 days). The average surgery time was 211±58 min (range=119-385 min), and average intraoperative bleeding volume was 288±267 ml (range=33-1,069 ml). No patient died of complications during the perioperative period.

The post group was significantly younger, and demonstrated a longer period from spine surgeon consultation to surgery than the pre group (*p*=0.0277 and 0.0498, respectively) (Table I). Only in patients treated for primary tumors at our hospital, the period from spine surgeon consultation to surgery in the post group was significantly longer than that in the pre group (*p*=0.0129) (Table II). The multivariate logistic regression analysis revealed that the period from spine surgeon consultation to surgery was significantly associated with visits to the specialized outpatient clinic (*p*=0.0460) (Table III). In contrast, no obvious factors affected the operation leaving time.

Discussion

Our findings reveal that the specialized outpatient clinic on bone metastasis prolonged the period from the first consultation of a spine surgeon to the surgery for patients with spinal metastasis who required surgery. Furthermore, this outpatient clinic significantly prolonged the waiting period until surgery. Moreover, it was possible to reduce the burden on spine surgeons by performing the surgeries with a margin.

Numerous articles have called for a multidisciplinary approach to bone metastasis (3-11). However, most of them did not shed light on the statistical validity. Thavarajah *et al.* reported on a shorter time to initiate radiation therapy. However, they did not demonstrate clinical efficacy (6). Nakata *et al.* evaluated 45 patients with bone metastasis to the spine with paralysis, and only revealed the clinical efficacy of the multidisciplinary approach (11). They reported that the cancer board shortened the time to diagnosis and treatment, besides reducing the incidence of paralysis. A multidisciplinary approach that amalgamates interdisciplinary staff, such as the cancer boards is considered important in modern cancer treatments, owing to the increasing prognosis. This necessitates applying the concept in maximum institutions providing cancer treatment.

Table I. Comparison of all cases before and after initiating the specialized outpatient clinic on bone metastasis.

	Post group	Pre group	p-Value
Number	15	16	
Age (years)	63.4±9.8	71.0±8.5	0.0277
Gender - Male/Female	7/8	9/7	0.8619
Primary tumor treatment at our hospital			0.8786
Present/None	9/6	9/7	
Paralysis or bladder and rectal disorder			0.6002
Present/None	7/8	10/6	
Severity of neurological deficit – Frankel classification			0.3217
A/B/C/D	0/0/4/3	0/0/9/1	
Denosumab usage			0.9738
Present/None	1/14	0/16	
Period from spine surgeon consultation to surgery (days)	13.3±13.4	5.6±5.0	0.0498
Surgery time	197±49	226±64	0.1604
Operation room leaving time – after 20:00			0.5649
Present/None	5/10	8/8	
Intraoperative bleeding volume (ml)	331±291	246±244	0.3818
Preoperative embolization			
Present/None	8/7	4/12	0.2114

Values are expressed as the number and proportion of patients or mean±standard deviation (SD) with ranges.

Table II. Comparison of patients treated for primary tumors at our hospital before and after initiating the specialized outpatient clinic on bone metastasis.

	Post group	Pre group	p-Value
Number	9	9	
Age (years)	61.9±11.5	68.2±8.1	0.1958
Gender - Male/Female	4/5	4/5	0.6353
Paralysis or bladder and rectal disorder			1.0000
Present/None	3/6	4/5	
Severity of neurological deficit			
Frankel classification - A/B/C/D	0/0/1/2	0/0/4/0	0.2771
Severity of neurological deficit after surgical treatment			-
Frankel classification - A/B/C/D/E	0/0/1/1/1	0/0/0/4/0	
Denosumab usage			1.0000
Present/None	1/8	0/9	
Period from spine surgeon consultation to surgery (days)	16.2±9.2	5.9±6.2	0.0129
Surgery time	184.3±54.7	215.2±59.5	0.2684
Operation room leaving time – after 20:00			0.1336
Present/None	1/8	5/4	
Intraoperative bleeding volume (ml)	215±148	191±92	0.6802
Preoperative embolization			
Present/None	5/4	1/8	0.1336

Values are expressed as the number and proportion of patients or mean±standard deviation (SD) with ranges.

However, meetings may be limited to once or twice a month, thus warranting a system that frequently monitors patients to rapidly notice and respond to those who are likely to develop paralysis. At our facility, we previously tried to continue the cancer board. However, we were

unable to obtain the frequent cooperation from various professionals. Therefore, only one orthopedic surgeon began the specialized outpatient clinic on bone metastasis at our hospital. Outpatient treatment for approximately 2 h a week enabled extensively guiding patients with spinal metastases

Table III. Multivariate logistic regression analysis of patients treated for primary tumors at our hospital.

Variables	Multivariate		
	OR	95% CI	p-Value
Period from spine surgeon consultation to surgery- <5 days			
Age	1.022	0.880-1.185	0.7781
Gender - Female	1.350	0.103-17.772	0.8194
After outpatient clinic for bone metastasis	0.059	0.004-0.951	0.0460
Paralysis or bladder and rectal disorder	4.760	0.350-64.675	0.2412
Operation room leaving time- after 20:00			
Age	1.023	0.890-1.176	0.7518
Gender-Female	0.181	0.009-3.763	0.2698
After outpatient clinic for bone metastasis	0.075	0.004-1.402	0.0829
Paralysis or bladder and rectal disorder	1.878	0.152-23.246	0.6234
Surgery time	0.997	0.970-1.025	0.8303

OR: Odds ratio, CI: confidence interval.

who required surgical treatment. The involvement of more orthopedic surgeons and spine surgeons at this outpatient clinic would significantly reduce the burden on each doctor. Adopting a multidisciplinary approach, such as a cancer board would be ideal. However, considering its difficulty, it would be effective to initially develop specialized outpatient clinics on bone metastasis that can be easily initiated at any facility.

Spine surgeons deal with numerous spinal disorders. Nonetheless, paralysis often requires an emergency surgery. The causes not only include bone metastasis of cancer but also infection and trauma. Therefore, surgery is extremely challenging. However, the specialized outpatient clinic on bone metastasis can supposedly reduce the burden on the spinal surgeons only for spinal metastasis. Considering the increasing prognosis of patients with cancer, a specialized outpatient clinic on bone metastasis, if not a multidisciplinary approach, will be required in future to reduce the burden on spine surgeons.

This was the first study to examine the usefulness of a specialized outpatient clinic on bone metastasis, and examine its impact on the burden on spine surgeons. However, our study had several limitations. The small sample size was the major limitation. It can be attributed to the inclusion of only patients who underwent surgery for spinal metastasis. The specialized outpatient clinic on bone metastasis extended the waiting period until surgery. Nonetheless, we could not determine if the change was because of early detection or slow response of the spine surgeon. To demonstrate the postoperative results, we would like to compare the degree of improvement in paralysis. Nevertheless, we could not make a sufficient evaluation considering few cases of paralysis. However, there was no difference in clinical data, such as the surgery time and

intraoperative bleeding volume. Moreover, the proportion of patients who left the operating room late or those who did not embolize before the surgery tended to be small after visiting the specialized outpatient clinic. Therefore, early detection will likely allow patients to respond with a margin. In addition, it is necessary to consider various factors, such as differences depending on the type of carcinoma, which could not be performed owing to the small sample size. We need to continue specialized outpatient clinic on bone metastasis for the next few years, and we intend to perform detailed studies with larger number of patients with bone metastasis requiring surgical treatment.

In conclusion, the present study demonstrated that the specialized outpatient clinic on bone metastasis had the possibility of reducing the burden on spinal surgeons by providing a margin for patients with spinal metastasis who required surgery. Because the number of patients with bone metastases is expected to increase, it is important to create a new system that will lead to early intervention for patients with bone metastases. Considering the difficulty to adopt a multidisciplinary approach, we should consider developing specialized outpatient clinics that can be sustained easily by an orthopedic surgeon alone.

Conflicts of Interest

The Authors report no conflicts of interest.

Authors' Contributions

All Authors were involved in the planning and reviewing of this research. Tsuchie H, Hongo M, Kasukawa Y, Nagasawa H, Kudo D, and Kimura R, collected the clinical data. Tsuchie H analyzed the raw data. Tsuchie H wrote this dissertation. Miyakoshi N reviewed the manuscript.

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Received August 16, 2021
 Revised September 13, 2021
 Accepted September 30, 2021