Hiroshima J. Med. Sci.
Vol.46, No.4, 125～131, December, 1997
HIJM 46–17

Treatment of Tumors of the Spine

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ABSTRACT

Thirty-one patients with spinal tumors underwent reconstructive surgery with our spinal instrumentation system (MPDS and MADS), with or without our new vertebral tumor prosthesis. The characteristics of the spinal tumors were analysed statistically and the treatment outcome was evaluated. There were 4 benign tumors, 6 malignant tumors, and 21 metastatic tumors. The malignant tumors involved the sacrum more frequently than the benign tumors (p=0.0098). Metastatic tumors involved the thoracic spine more frequently than benign or malignant tumors (p=0.0161). The average number of affected vertebrae was 1.2 in the benign tumors, 1.8 in the malignant tumors, and 2.4 in the metastatic tumors. The metastatic tumors had a tendency to involve the anterior or middle part of the spine more frequently than the benign or malignant tumors (statistically not significant). After surgery, neurological improvement was noted in 8 patients, nochange in 19 patients, and impairment due to resection of the nerve roots in sacral tumors in 4 patients.

***Key words**: Spinal tumors, Spinal instrumentation system, Metastatic tumors, Neurological improvement*

The spine is one of the most frequent sites for cancer metastasis. Spinal metastases cause severe pain and motor or sensory disturbance[11], and badly influence the quality of life of cancer patients. The spinal cord is compressed by the extending tumor into the spinal canal. It is also evident that spinal compression is caused by kyphotic deformity and by fracture fragments bulging into the spinal canal from the fractured vertebral body following a metastasis[19]. Although radiotherapy is one of the treatment choices for spinal metastasis, quadri- or paraparesis following vertebral fracture cannot successfully be managed by irradiation alone[11]. Patients with tumors of the spine are usually treated by instrumentation with removal of the tumor.

For the anterior spine, the Ventral Derotation Spondylodeses (VDS) according to Zielke has continued to be the golden standard[25]. There is no comparably powerful anterior implant that universally corrects a scoliotic deformity of any severity in all three planes. In comparison to modern posterior instrumentation systems[14], VDS is subject to the disadvantage of lacking primary stability, which is very important for reconstruction surgery after resection of spinal tumors. As to the spinal instrumentation of the posterior part, Harrington instrumentation has been replaced by polysegmentally fixating systems, especially Cotrel-Dubousset Instrumentation (CDI) and its newer derivates. A member of this team developed original spinal instrumentation for surgical correction of spinal deformity[7,8], and we applied this system to our patients with spinal tumors.

First we introduce our system. In our anterior system, the correction principles of the VDS in terms of using a threaded compression rod are maintained. After correction has been obtained, a solid, rotatory stable 5 mm rod is applied for augmentation of the system[7]. In tumor surgery, however, two corrugate rods instead of a VDS rod are usually used. Our posterior system follows the principles of modern double rod frame systems addressing the spine polysegmentally[8]. The special feature of our posterior system is a cap nut incorporating a set screw. In this paper, the character of the spinal tumors which we treated and the effect of surgery using our system to resolve the neurological problems are analysed.

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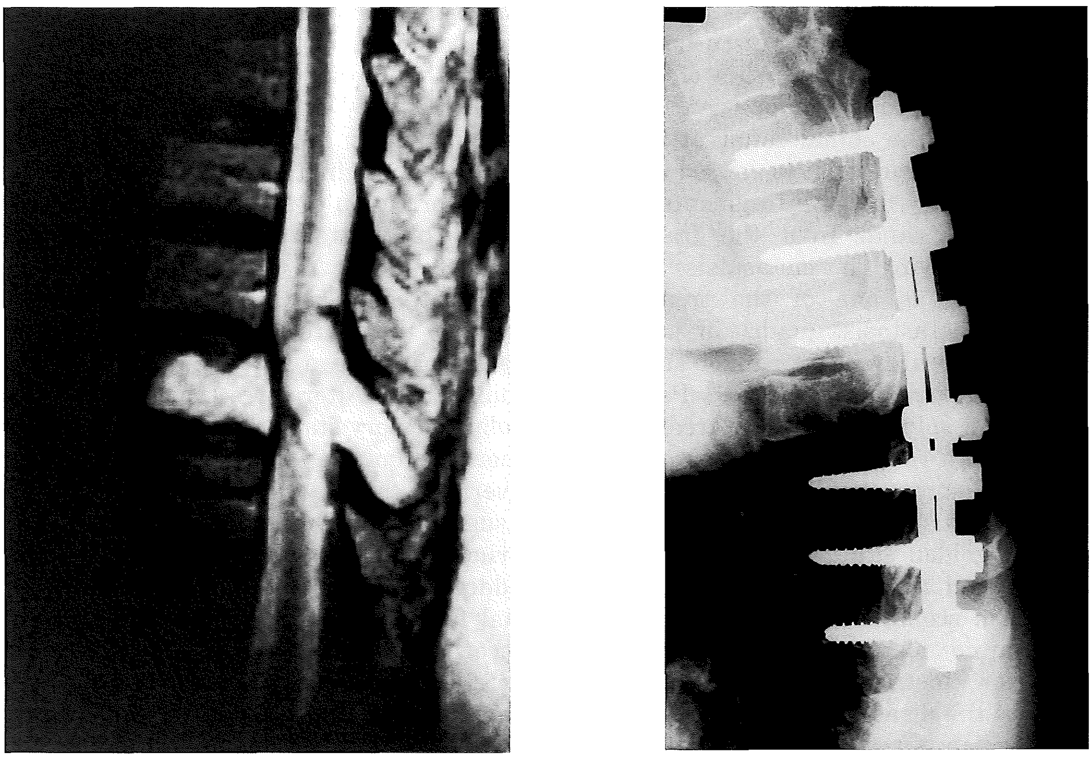
MATERIALS AND METHODS

Between 1994 and 1995, 31 patients with spinal tumors underwent spinal instrumentation with removal of the tumor. Twenty patients were male and 11 were female. The age of the patients ranged form 11 to 83 (median 38) years. In the patients with benign tumors, the age ranged from 11 to 48 (median, 27) years. In the patients with malignant tumors, age ranged from 12 to 66 (median, 38) years. In the patients with metastatic tumors, the age ranged between 12 and 83 (median, 57) years. There were 4 benign tumors and tumor-like lesions (aneurysmal bone cyst, 3; giant cell tumor, one), 6 malignant tumors (chordoma, 2; chondrosarcoma, one; Ewing's sarcoma, one; hemangiopericytoma, one, and vertebral infiltration of liposarcoma, one), and 21 metastatic tumors (renal cell cancer, 5; breast cancer, 3; lung cancer, 3; bladder cancer, 2; multiple myeloma, 2; malignant lymphoma, 2; testis cancer, one; Ewing's sarcoma, one; tonsil cancer, one, and metastasis of unknown origin, one) (Table 1). The part of the spine affected by the tumor was classified into anterior, middle, and posterior according to the method of Denis et al[4]. Twenty-seven patients underwent surgery with posterior instrumentation (MPDS, Münster Posterior Double-rod System) (Fig. 1). Three patients underwent sur-

Table 1. Patient Data

Benign	
Aneurysmal bone cyst	3
Giant cell tumor	1
Malignant	
Chordoma	2
Chondrosarcoma	1
Ewing's sarcoma	1
Hemangiopericytoma	1
Liposarcoma (invasion)	1
Metastasis	
Renal cell cancer	5
Breast cancer	3
Lung cancer	3
Bladder cancer	2
Multiple myeloma	2
Malignant lymphoma	2
Testis cancer	1
Ewing's sarcoma	1
Tonsil cancer	1
Unknown origin	1



A B

Fig. 1. A 51 year-old woman with a metastatic breast cancer of the 10th thoracic spine. She showed incomplete parapresis preoperatively. A: T2-weighted magnetic resonance imaging showed high signal intensity tumor area in the anterior, middle, and posterior part of the spine. B: An X-ray after posterior procedures. Neurological findings improved.

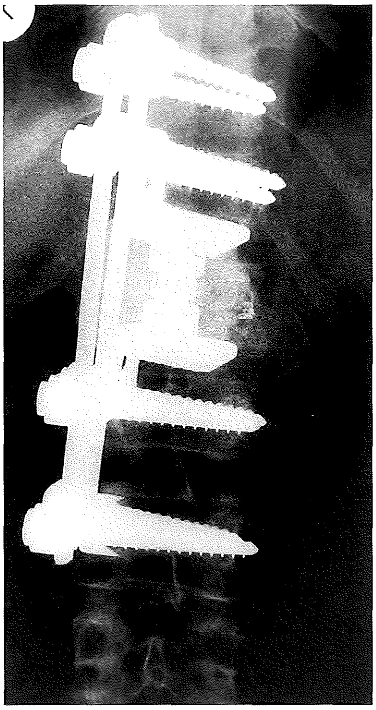


Fig. 2. A 55-year-old man with a metastatic renal cell cancer of the 1st lumbar spine. An X-ray was taken after implantation of the metallic spacer by anterior procedures. Neurological deficit was noted neither before nor after surgery.

gery with anterior instrumentation (MADS, Münster Anterior Double-rod System) (Fig. 2). Two patients underwent surgery from the anterior approach followed by posterior instrumentation. For vertebral body replacement after removal of the metastasis, a new tumor prosthesis was implanted in 6 patients, an allograft in one, and an autograft (fibula, 2; rib, 2) in 4.

Neurological evaluation was done both preoperatively and one month after surgery according to the Frankel scale[6] (Table 2). In 20 patients, information on bladder function was available. Follow-up ranged between 6 months and 30 months (median 17 months). Contingency table analyses were used to determine the relationship between 2 nominal variables. The nonparametric Mann-Whitney U-test was employed to compare the ranked means of 2 groups.

RESULTS

Characteristics of the spinal tumors

Two benign tumors originated from the thoracic spine and 2 from the lumbar spine (Fig. 3). One malignant tumor originated in the lumbar spine and 5 malignant tumors in the sacrum. Malignant tumors involved the sacrum more frequently than benign tumors ($p=0.0098$). Two metastatic tumors affected the cervical spine, 18 the thoracic spine, 7 the lumbar spine, and one the sacrum

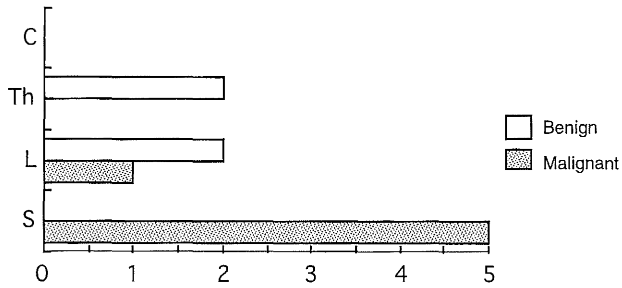


Fig. 3. The level of the spine affected by 10 primary tumors.

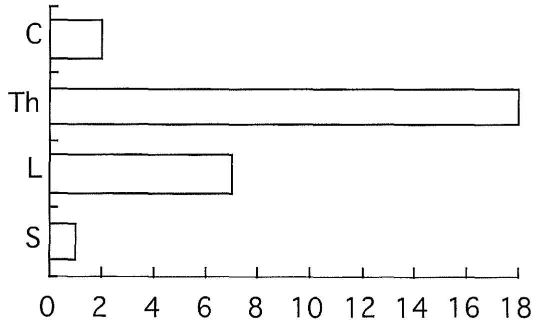


Fig. 4. The level of the spine affected by 21 metastatic tumors.

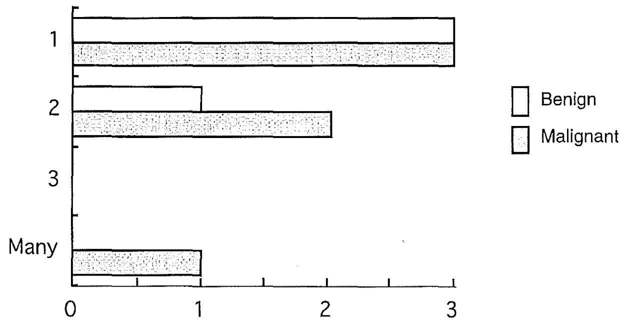


Fig. 5. The number of the vertebrae affected by 10 primary tumors.

(Fig. 4). The number of vertebrae affected by the metastatic cancers include all sites of metastases. Metastatic tumors involved the thoracic spine more frequently than the benign or malignant tumors ($p=0.016$).

Three benign tumors affected only one vertebra, and one benign tumor (aneurysmal bone cysts) 2 vertebrae (Fig. 5). Three malignant tumors affected only one vertebra, 2 malignant tumors 2 vertebrae, and one several vertebrae. Ten metastatic tumors affected only one vertebra, 3 metastases 2 vertebrae, 4 metastases 3 vertebrae, and 4 metastases several vertebrae (Fig. 6). The average number of affected vertebrae was 1.2 in the benign tumors, 1.8 in the malignant tumors, and

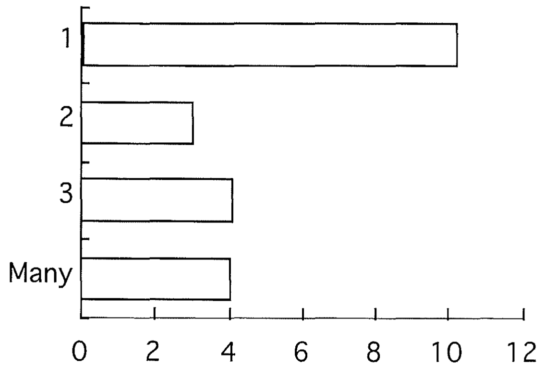


Fig. 6. The number of the vertebrae affected by 21 metastatic tumors.

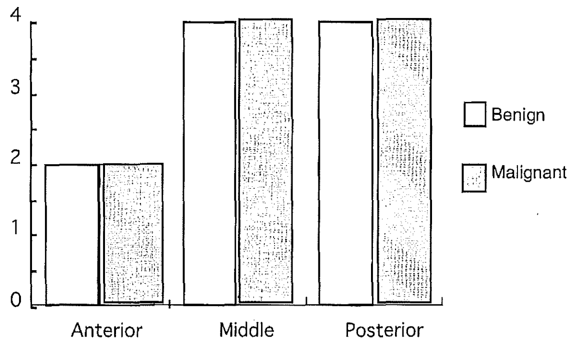


Fig. 7. The part of the spine affected by 10 primary tumors.

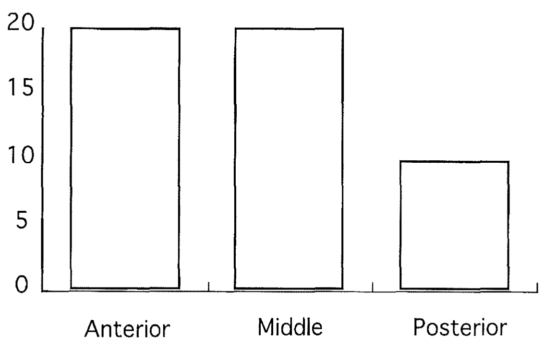


Fig. 8. The part of the spine affected by 21 metastatic tumors.

2.4 in the metastatic tumors. Concerning the average number of affected vertebrae between benign or malignant tumors (1.6) and metastatic tumors (2.4), the difference was not significant (p=0.510).

The distribution of the affected part in the vertebrae of malignant and benign tumors was the same: anterior part invasion was noted in 2 patients, middle part invasion was noted in 4 patients, and posterior part invasion in 4 patients (Fig. 7). The following distribution of metastatic tumors was noted: anterior invasion, 20 patients, middle part invasion, 20 patients, and posterior part invasion, 8 patients (Fig. 8). If the affected parts were divided into 2 groups (anterior or middle and posterior), the difference between benign or malignant and metastatic tumors was not significant (p=0.0837).

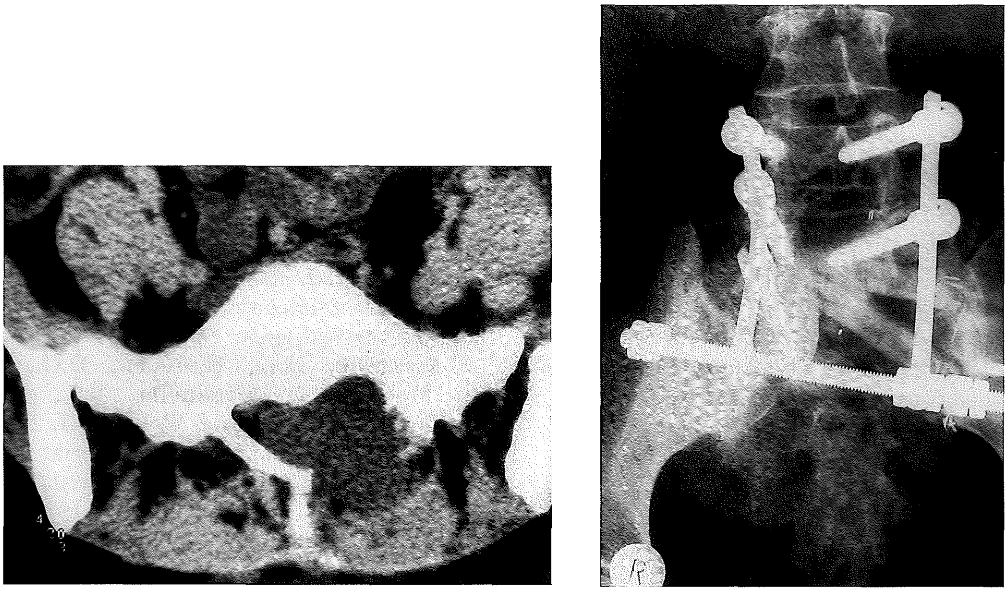
Table 2. Frankel's scale

Diagnosis	preop.	postop.
Benign	D: 1	D: 1
	E: 3	E: 3
		No change: 4
Malignant		B 1
	D: 5	C: 2
	E: 1	D: 3
		Improved: 0
		No change: 3
		Impaired: 3
Metastasis	B: 2	B: 1
	C: 2	C: 2
	D: 8	D: 4
	E: 9	E: 14
		Improved: 8
		No change: 12
		Impaired: 1

In 4 patients with benign tumors, one patient was preoperatively classified in D and 3 in E. These results did not change before and after surgery. In 6 patients with malignant tumors, 5 patients had D and one patient E. However postoperatively, one had B, 2 had C, and 3 had D due to necessary resection of the nerve roots in primary malignant tumors for complete tumor resection. Improvement was not noted, there was no change in 3 patients, and impairment was noted in 3 patients. In 21 patients with metastatic tumors, 2 had B, 2 had C, 8 had D, and 9 had E preoperatively. Postoperatively, one had B, 2 had C, 4 had D, and 14 had E. Improvement was noted in 8 patients, no change in 12 patients, and impairment in one patient. In 17 of 20 patients, improvement of the bladder function was noted. At the time of writing, all patients with benign or malignant tumors are alive. However, 6 patients with metastases have died.

DISCUSSION

Our MADS and MPDS systems were developed between 1992 and 1994. Up to now, some reports have been published on the advantage of these systems for spinal deformities, especially for surgery of scoliosis[7,8]. In recent years, the population of the elderly continues to increase in comparison with that of the young or middle



A B

Fig. 9. A 34-year-old woman with hemangiopericytoma of the sacrum. A: Computed tomography shows osteolytic lesion of the posterior part of the sacrum. B: After tumor resection, reconstruction was done using the MPDS and the sacral bar. A neurological finding was not changed after surgery.

aged, so the number of metastatic tumors of the spine is also increasing. Currently, the quality of life is highly respected in the treatment of patients with cancer. As a result, the treatment of spinal metastasis is one of the most important problems in the orthopaedic field[15].

The most frequent site of benign spinal tumors was the thoracic or lumbar spine, that of malignant tumors was the sacrum, and that of metastasis was in the thoracic spine. The distribution pattern of benign tumors was influenced by the fact that most of the aneurysmal bone cysts affected the lumbar or thoracic spine[20]. If we diagnose tumors in the sacrum, we should always suspect malignancy (Fig. 9). In metastatic tumors, the number of vertebrae targeted by metastasis may be related to anatomy. There are 12 vertebrae in the thoracic spine; this is more than in the cervical, lumbar, and sacral regions.

For all spinal tumors, involvement of one vertebra is the most frequent phenomenon. In metastatic tumors, however, involvement of 3 or more vertebrae is also noted. Two benign tumors infiltrated 2 vertebrae because aneurysmal bone cyst sometimes affects more than one vertebra[20]. Fifty-two % of the metastatic tumors involved more than, or at least, 2 vertebrae, and this led to difficulties in the removal and replacement of the vertebral bodies.

In the benign tumors, the predilection areas of aneurysmal bone cysts are the posterior elements of the vertebra[3,10,12,20]. The vertebral bodies are the more frequently affected sites of metastasis than the posterior elements of the spine[13]. This tendency was also noted in this series.

For benign tumors, cementation[20], cryosurgery[16], or an ultrasonic surgical aspirator[24] may be used as an effective means of local control. However, in malignant tumors, surgical resection is the first choice of local treatment. If a tumor occurs in the posterior component of the spine, the optimal treatment is decompression by a laminectomy followed by stabilization. However, Sundaresan et al[22] found that only 4 of 62 patients with epidural cord compression from metastasis had compressive masses that were purely posterior in location. When a metastasis affects the vertebral body, the vertebra loses its mechanical integrity with subsequent collapse[1]. These findings suggest that an anterior or anterolateral approach may be more appropriate in most patients with cord compression by metastasis[11]. We think that an approach either anterior or posterior should be considered individually. The condition of the patient is a very important factor in deciding the approach. If the patient has an expected survival time of less than 6 months, the less invasive posterior procedure may be suitable. If, however, the expected survival time is longer than 6 months, the anterior support can be performed at a convenient time when the patient is in optimal condition[19]. On the other hand, Tomita et al reported neurological improvement and no local recurrences at the last follow up visit after extensive resection only from the posterior[23]. One problem is that an indication of the suitability of this method is limited for tumors in a relatively early stage with neither paravertebral, adjacent vertebral, nor multiple vertebral development[23]. In this series, 50% of the patients with metastasis were not suitable for this approach.

There are various materials for replacement of the collapsed vertebra. Autogenous bone grafts have been applied, although incorporation of the grafted bone is difficult due to radiation to prevent local recurrence[9]. If local recurrence develops, the grafted bone is destroyed and absorbed by the tumor, and spinal instability redevelops[11]. Polymethylmethacrylate was subsequently widely used to reconstruct collapsed vertebrae[2,5,21]. Bone cement can be molded to the desired shape, and its solidity is not influenced by radiotherapy[18]. However, fatigue fracture of the implanted cement occasionally occurs[17]. If survival time was expected to be longer than 6 months in these patients, we implanted a new modular metal spacer after removal of the vertebra involved by the tumor. This material seems to be optimal and we can modify the size (length) between the upper and lower ends of the vertebrae. It can easily be connected to MADS, which makes luxation or subluxation with subsequent instability impossible. In metastatic cancers, 20 of 21 patients had satisfactory results (improved or no change) after surgery.

In patients with malignant tumors 3 of 6 cases a worse neurological condition was expected after surgery. These 3 were patients with primary malignant tumors of the sacrum, and sacrectomy with resection of all the sacral roots and unilateral L5-roots was inevitable for acquiring a safe margin. In surgery of primary malignant tumors of the spine, education of the patients and careful explanation of the advantage of surgery and the disadvantages of sacrificing the nerve roots is necessary.

This is a report of our experience in the treatment of spinal tumors. There are several characteristics of the involvement of the spine by spinal tumors. The neurological results after surgery were satisfactory. The fact that no implant related complications occurred (no rod or screw breakage, no hook luxation), demonstrates that MADS + MPDS provide a primary stable system, as all patients were ambulated without external support. Investigation of its use will be continued.

(Received July 24, 1997)
(Accepted November 27, 1997)

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