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Abstract

Surgical treatment of metastatic spinal cord compression is controversial. The purpose of this study was to investigate the effectiveness of our current surgical treatments and the use of spinal instrumentation. In this retrospective study covering the years between 1990 and 2006, 100 patients with spinal metastases which were secondary to various cancers underwent posterior and/or anterior decompression with spinal stabilization for the purposes of reduction of pain, and/or to help correct or improve neurological deficits. The group was made up of 60 men and 40 women whose ages ranged from 16 to 83 years (average of 60 years), and the average follow-up period was 14 months. The effect of treatment upon pain relief and neural deficits was assessed, and the cumulative survival rate was calculated by the Kaplan-Meier method. The average surgical time was 185min. This was calculated based on the following times, listed here with the surgery type:178min for posterior surgery;245min for anterior surgery;465 min for combined surgery;and 475min for total en bloc spondylectomy. Average blood loss during surgery was 1,630 ml for posterior surgery, 1,760 ml for anterior surgery, 1,930 ml for combined surgery, and 3,640 ml for total en bloc spondylectomy. Preoperative pain and paralysis were improved by 88% and 53%, respectively. In regards to surgical complications, postoperative epidural hematoma was observed in 2 patients, and instrumentation-related infection was observed in 1. Only 2 patients died within 2 months of surgery. In conclusion, posterior and/or anterior decompression with spinal stabilization is a safe and effective treatment for patients with spinal metastases, and can improve their quality of life.

KEYWORDS: spinal metastasis, spinal surgery, instrumentation

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Original Article

Surgical Treatment of Metastatic Vertebral Tumors

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Surgical treatment of metastatic spinal cord compression is controversial. The purpose of this study was to investigate the effectiveness of our current surgical treatments and the use of spinal instrumentation. In this retrospective study covering the years between 1990 and 2006, 100 patients with spinal metastases which were secondary to various cancers underwent posterior and/or anterior decompression with spinal stabilization for the purposes of reduction of pain, and/or to help correct or improve neurological deficits. The group was made up of 60 men and 40 women whose ages ranged from 16 to 83 years (average of 60 years), and the average follow-up period was 14 months. The effect of treatment upon pain relief and neural deficits was assessed, and the cumulative survival rate was calculated by the Kaplan-Meier method. The average surgical time was 185 min. This was calculated based on the following times, listed here with the surgery type: 178 min for posterior surgery; 245 min for anterior surgery; 465 min for combined surgery; and 475 min for total en bloc spondylectomy. Average blood loss during surgery was 1,630 ml for posterior surgery, 1,760 ml for anterior surgery, 1,930 ml for combined surgery, and 3,640 ml for total en bloc spondylectomy. Preoperative pain and paralysis were improved by 88% and 53%, respectively. In regards to surgical complications, postoperative epidural hematoma was observed in 2 patients, and instrumentation-related infection was observed in 1. Only 2 patients died within 2 months of surgery. In conclusion, posterior and/or anterior decompression with spinal stabilization is a safe and effective treatment for patients with spinal metastases, and can improve their quality of life.

Key words: spinal metastasis, spinal surgery, instrumentation

Bones, especially the spinal column, are target organs for distant metastasis of malignant tumors. Prostate, breast, lung, and thyroid cancers frequently metastasize to bones [1], with 80 percent of bone metastases occurring in the lumbar spine, and the remainder concentrated mostly in the ribs, sternum, and pelvis [2]. Primary malignant spinal tumors and solitary vertebral metastases of selected tumors in the spine are indications for spinal surgery. Recent advances in spinal instrumentation, coupled with new developments in surgical technology, have made various new surgical modalities available for treating

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spinal metastases [3].

It is important during the treatment of metastatic spinal tumors for individual physicians to select the appropriate therapy. The purpose of this study was to investigate the effectiveness of our current surgical treatments and the use of spinal instrumentation.

Patients and Methods

In this retrospective study, 100 patients with spinal metastases which were secondary to various cancers underwent surgery between 1990 and 2006 for the purposes of spinal fusion, the reduction of pain, and/or the correction or improvement of neurological deficits. (Patients who were not followed for more than 6 months were excluded from the final data in this study.) The group consisted of 60 men and 40 women who ranged in age from 16 to 83 years (average age of 60 years) at the time of surgery. Our surgical indications for spinal metastasis were: 1) pain and/or paralysis due to spinal instability, which was defined as more than 5 mm translation and/or 10 degrees angulation; 2) rapidly progressing paralysis; 3) concomitant definitive diagnosis of a spinal lesion of unknown origin or a well-controlled primary lesion; and, most importantly, 4) a localized metastatic lesion. When metastasis involved only 1 or 2 vertebrae, an anterior or anterior/posterior procedure was used for total tumor resection. Multiple lesions principally were treated via a posterior procedure for neural decompression. Postoperative follow-up periods ranged from 1 month to 7 years, with a mean of 14 months.

Primary lesions are summarized in Table 1. There were 17, 57, and 26 patients with metastatic lesions at the cervical, thoracic, and lumbar levels, respectively. As to surgical procedures, 78 patients were treated via a posterior approach, 10 via an anterior approach, and both anterior and posterior approaches were used in 4 patients. (Of the patients treated via a posterior surgical approach only, 73 received a laminectomy plus posterior stabilization, and 5 received a laminectomy alone.) The remaining 8 patients underwent total en bloc spondylectomy via a posterior approach. It is worth noting, however, that such a treatment is only indicated for patients whose primary tumors had a low degree of malignancy, such as renal and thyroid cancers, and whose bony metastatic lesions are limited to one vertebral body (Table 2).

Before surgery, patients were examined with plain anterior-posterior and lateral radiographs of the affected spinal segment, computed tomography with sagittal reconstructions of the involved vertebra, and magnetic resonance imaging. Computed tomography of the chest, abdomen, and brain were performed in each patient with suggestive clinical findings. Patients with radiosensitive tumors and mild paralysis received preoperative irradiation, whereas, generally, those requiring emergency surgery due to severe paralysis were irradiated postoperatively with 30–50 Gy. Some patients did not receive radiation treatment because their tumors were considered to be insensitive to radiation therapy.

Clinical data relating to pain and paralysis were analyzed prior to surgery and compared with observations performed 1–2 months after surgery. In each time period, pain was graded from 1 to 4 (Table 3) and paralysis was assessed by Frankel's classification system [4] (Table 4). The efficacy rate (the percentage of patients showing improvement or maintaining the best grade within a certain category) was calculated for each variable (efficacy rate = best score or improvement / total × 100%).

Spinal instrumentation systems were selected for all patients with metastatic spinal tumors. The vertebrae superiorly and inferiorly adjacent to the affected vertebra became involved for stabilization.

Table 1 Primary lesions of metastatic vertebral tumors

Lung cancer	19	Thyroid cancer	6
Myeloma	13	Stomach cancer	3
Prostate cancer	11	Liver cancer	3
Breast cancer	10	Unknown origin	4
Renal cancer	7	Others	24

Table 2 Surgical procedure

	Anterior	Posterior	Anterior & Posterior	TES*	Total
Cervical	10	6	1	0	17
Thoracic	0	50	1	6	57
Lumbar	0	22	2	2	26
Total	10	78	4	8	100

TES* = Total en-bloc Spondylectomy

Results

The duration of surgery for all procedures ranged from 95 to 975 min (average of 185 min), with means of 178 min for posterior procedures, 245 min for anterior procedures, 465 min for anterior plus posterior procedures, and 475 min for total en bloc spondylectomies. Blood loss for all surgeries ranged from 110 to 18,000 ml (average of 1,100 ml), and the mean blood loss for each procedure was 1,630 ml for posterior procedures, 1,760 ml for anterior procedures, 1,930 ml for anterior plus posterior procedures, and 3,640 ml for total en bloc spondylectomies.

Preoperative and postoperative pain level scores are summarized in Table 5. The efficacy rate was 88%, and no patients had an increase in pain level. Five of 10 patients who showed no pain reduction after the initial surgery also underwent laminectomy plus stabilization via a posterior approach for lesions that had metastasized from the lungs.

According to the Frankel's paralysis classification system, postoperative paralysis grades were A, B, C, D, and E in 5, 9, 10, 54, and 22 patients, respectively, with a mean efficacy rate of 53% (Table 6). Paralysis worsened in 7 patients (7%); it is perhaps of note that these patients' mean blood loss of 4,618 ml was significantly higher than the blood loss of the other patients (1,672 ml, $p < 0.01$).

The postoperative cumulative survival rate of all patients was 57% after 1 year, 35% after 2 years, and 22% after 3 years (Fig. 1). Correlated to primary lesions, the one-year survival rates were 100% for renal cancer and multiple myeloma; 88% for prostate cancer; 75% for thyroid cancer; 63% for breast cancer; 32% for lung cancer; and 0% for liver cancer (Fig. 2). Patients with lung or liver cancer had significantly poorer outcomes than patients with other forms of cancer ($p < 0.01$), and the majority of them died within one year of surgery. Only 2 patients died within 2 months of surgery.

Postoperative epidural hematoma was observed in 2 patients and instrumentation-related infection was observed in one. However, these were the only apparent surgical complications, and neither neurovascular injuries nor instrumentation breakdowns were recorded.

Case presentation. The patient was a 68-year-old woman with a metastatic second lumbar

Table 3 Pain grade

Ⅰ	no pain
Ⅱ	mild pain, no need NSAIDs
Ⅲ	moderate pain, need for NSAIDs
Ⅳ	severe pain, need for morphine

Table 4 Frankel's grade

A	complete motor and sensory loss
B	complete motor and incomplete sensory loss
C	some motor function but no practical use
D	useful motor function, incomplete sensory loss
E	normal motor and sensory function

Table 5 Preoperative and post operative pain grade

	Pain grade	Preoperative	Postoperative
Ⅰ	no	5	51
Ⅱ	mild	15	36
Ⅲ	moderate	62	11
Ⅳ	severe	18	2

Table 6 Preoperative and post operative Frankel's grade

Frankel's grade	Preoperative	Postoperative
A	8	5
B	9	9
C	41	10
D	36	54
E	6	22

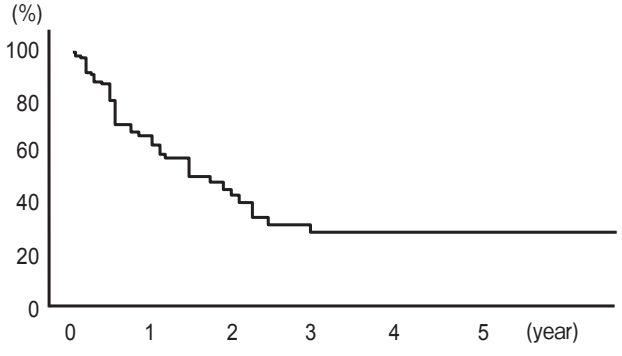

Fig. 1 Total survival rate. The postoperative, cumulative survival rate in all patients was 57% after 1 year, 35% after 2 years, and 22% after 3 years.

tumor arising from thyroid cancer. She presented with back pain and paralysis; preoperative MRI and CT imaging showed a collapse of the second lumbar spine and dural tube compression. A CT-guided biopsy confirmed a metastatic lesion resulting from thyroid cancer, while systemic examination revealed no clear evidence of metastases in other regions. Total en bloc spondylectomy of the second lumbar spine was performed according to Tomita's technique [5], and the region from T12 to L4 was rigidly fixed posteriorly using the TSRH system (Medtronic Sofamor Danek inc, Memphis, TN, USA) (Fig. 3). The patient was completely relieved from back pain and paralysis, and could once again stand up and walk. Three and a half years after surgery, she maintains independent ambulation.

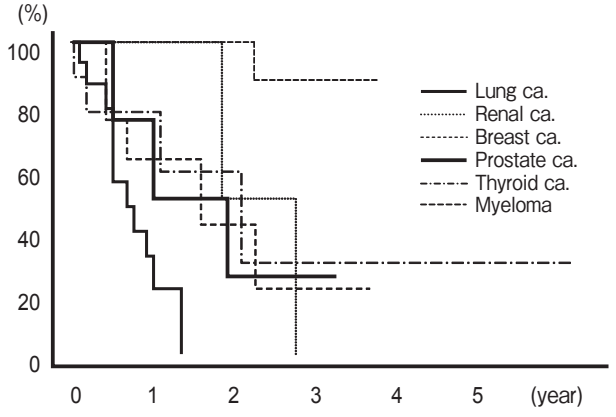

Fig. 2 The survival rate according to primary cancer. For primary lesions, the 1-year survival rates were 100% for renal cancer and multiple myeloma, 88% for prostate cancer, 75% for thyroid cancer, 63% for breast cancer, and 32% for lung cancer.

Discussion

Surgical indications and procedures for metastatic spinal tumors. Metastatic spinal tumors invariably create substantial restrictions on daily activities due to pain and/or paralysis resulting from the destruction of the spinal cord and its support system [6]. Recent developments in spinal instrumentation and advances in spine-related surgical techniques now allow for vastly improved, more comprehensive, aggressive local treatment that can more fully facilitate healing in the affected area; in some cases, the use of spinal column support is a critical component in such treatment [3]. Our indications for surgery were: 1) pain and/or paralysis due to spinal instability (more than 5 mm translation and/or 10 degrees angulation); 2) rapidly progressing paralysis; 3) concomitant definitive diagnosis of a spinal lesion of unknown origin or a well-controlled primary lesion; and 4) a localized metastatic lesion. This last indication was of critical importance, as it generally made aggressive local treatment both possible and necessary.

There are some useful scoring systems for evaluating surgical indications for metastatic spinal tumors

Fig. 3 68-year-old woman with thyroid cancer. Preoperative CT and MRI show metastatic L2 tumor, arising from thyroid cancer. Second lumbar spine collapse and dural tube compression were imaged. En bloc spondylectomy of L2 was performed according to Tomita's technique.

[7, 8]. Tokuhashi's scoring system includes 6 parameters: 1) the patient's general condition : 2) the number of extraspinal bone metastases; 3) the number of metastases in the vertebral body; 4) metastases to the major internal organs; 5) the primary site of the cancer; and 6) the severity of spinal cord palsy. The system's range of scores is from 0 to 15, with excisional surgery recommended for those cases who score above 9 points, and a palliative operation indicated for those who score under 5 points [7].

It has been reported that the life expectancy of patients with metastatic vertebral tumors--such as lung, stomach, esophagus, pancreas, or liver cancer--is shorter than that of patients suffering from other primary cancers [7, 8]. In this study, the same tendency was observed in patients with lung, stomach, and liver cancer. Surgeons who perform spinal surgical intervention upon patients diagnosed with these primary cancers may need to consider the implications of such data.

Effectiveness of and problems with spinal instrumentation. Spinal instrumentation is required to achieve spinal support immediately after surgery. The insertion of a pedicle screw at the thoracolumbar level is not a problem, but may cause complications, such as neurovascular injury, if applied at the cervical level. Thus one should use pedicle screws at the cervical level only after carefully considering the potential risks involved. Moreover, special care should be taken with regard to the potential for infection when using a cage, which is required in many cases for the reconstruction of anterior support following the extraction of a vertebral body.

Surgical results and problems. Recent reports show that 67 to 91% of patients who receive irradiation and 68 to 100% of those who undergo surgical treatment for spinal metastases experience pain relief [9]. Due to their high radiosensitivities, the tumors of malignant lymphoma, multiple myeloma, breast cancer, and prostate cancer should always be treated with preoperative radiotherapy [10]. Unfortunately, the results are not as encouraging—or as even—when one considers the effects of irradiation on paralysis. For one thing, irradiation is not very effective for improving paralysis when compared to surgical treatment [10]. For another, the overall reported efficacy rate for the improvement of paralysis by irradiation varies greatly, ranging from 32 to 89%. The efficacy of surgery is affected by factors such as the presence of primary lesions, the degree of preoperative paralysis, and the type of surgical procedure performed [7]. Paralysis in patients with lung or stomach cancer tended to respond poorly to treatment, which suggests that the histological type of the primary lesion by itself affects not only the patient's vital prognosis, but also the improvement of paralysis.

Ibrahim *et al.* reported on the surgical treatment of 223 spinal extradural metastases [11]. The incidence of perioperative death (within 30 days) was 5.8% in this study and 2% in our study. Postoperatively, 71% of the patients noted a reduction in pain level, and 73% of the patients were able to regain movement and/or improve their Frankel grade. Our results were similar to this report, so it appears that surgical intervention should be considered a safe and effective treatment for patients with spinal metastases, and one that can improve their quality of life.

Since patients in our study whose paralysis worsened after surgery tended to undergo significantly greater blood loss during surgery, it seems that the formation of a postoperative epidural hematoma may aggravate the paralysis. Preoperative embolization should be performed as much as possible, and is essential for the treatment of tumors which bleed more easily, such as renal and thyroid cancers [12, 13].

Conclusions. Posterior and/or anterior decompression with spinal stabilization is a safe and effective treatment for patients with spinal metastases, and one that can improve their quality of life. Preoperative pain and paralysis were improved by 88% and 53%, respectively, in this study. However, patients with lung or liver cancer had significantly poorer outcomes when compared with patients with other cancers.

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