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Minimally invasive solid long segmental fixation combined with direct decompression in patients with spinal metastatic disease

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ABSTRACT

This study seeks to discuss the efficiency of minimally invasive surgery of posterior long segmental fixation plus direct decompression in patients with spinal metastatic tumors. Twenty-five patients received minimally invasive surgery of long segmental fixation combined with direct decompression from posterior approach. Pain and neurologic improvement in these patients pre- and post operation were evaluated by Denis' Pain Scale and Frankel Score, respectively. Seventeen patients (68.0%) showed significant decreases in Denis' Pain score after surgery ($p < 0.0001$). Paralysis symptoms were improved in nineteen patients (76.0%). The Frankel Score exhibited significant difference between pre-operation and post-operation ($p < 0.0001$). Operation time and blood loss in this cohort were 324 ± 90 min and 1047 ± 730 ml, respectively. No fatal complications were observed as a result of surgery. In conclusion, minimally invasive surgery of posterior long segmental fixation combined with direct decompression is a safe and efficient strategy to release pain and improve neurological function in patients with spinal metastatic tumors.

1. Introduction

Bone metastases generally occur during the terminal period of life in patients with malignant tumors. The spine is the most common site where bone metastasis occurs and accounts for 5–10% of patients with systemic cancer.[1,2] In patients with spinal metastasis, 90% presented with pain and 47% presented with neurological deficits. Intolerant pain is one of the major symptoms that deteriorate a patients' quality of life while neurological deficits significantly limit the patients' ambulation.[3,4]

Radiotherapy has been adopted to control pain in patients with spinal metastasis cancer. Reports showed that about 60% of patients can gain significant pain relief after radiation of spinal metastasis.[3,5] However, the efficiency of pain relief is greatly limited to radiation-sensitive tumors. Also, radiotherapy cannot effectively release pain resulting from direct compression of neural tissue, such as pathological fracture, instability of affected spine segment, and movement. Unfortunately, most spinal metastasis damages the vertebral part of the spine, which shares 80–90% of the axial load. This means that the spine is at great risk of collapse and surgical fixation is necessary.

Although total en bloc spondylectomy of a solitary lesion can improve prognosis, its necessity is still debated because it is incurable for the primary cancer, has the challenge of anatomic difficulty, and the patients usually have poor prognosis and short life expectancy.[6,7] Therefore, most surgical strategies in spinal metastases are focused on improving the quality of life through pain relief and improvement of neurologic function.[8,9] Solid fixation with long segmental instruments is widely used in idiopathic or acquired spinal deformity correction and has been shown to be excellent in maintaining stability of the spine. Minimally invasive surgery in the spine has been generally characterized by significantly less blood loss, shorter hospital stay, and less complications.[10] However, to our knowledge, most of the minimally invasive surgeries of the spine were focused on single level and degenerative disease. Long segments fixation with minimally invasive surgery is rarely used in metastatic spinal lesions.

In the current study, we review 25 cases of minimally invasive operation of solid fixation with long segmental instruments

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combined with decompression during the surgery from Apr. 2004 to Oct. 2010. We discuss the surgical procedure, pain relief, blood losses, and the complications peri-operation.

2. Materials and methods

2.1. Patients

We performed a retrospective study of 25 patients who suffered from spinal metastases and were treated in the Division of Orthopedic Oncology, National Cancer Center Hospital in Tokyo, Japan from April 2004 to October 2010. All patients received palliative treatment with minimally invasive surgery of posterior long segmental fixation with direct decompression. The inclusion criteria included that the Tomita Prognostic Score of the patients[11] must be between 3 and 8. For radiosensitive tumors, surgery was performed only when there was evidence of unstable spine or compression of the spinal cord in which radiotherapy would not be effective. Patients with resectable solitary metastases or lesions located within the thoracic or lumbar vertebrae were given en bloc spondylectomy and were excluded from the current study. These 25 patients were composed of 15 men and 10 women with an age of 57.8 ± 10.5 years.

Symptoms that prompted surgical management of spinal metastases include neurological deficits, intolerable pain, and signs of spinal instability. A preoperative evaluation of prognosis was performed using Tomita prognostic scoring system.[11] Patients with prognostic scores between 3 and 8 were considered ready for operation. The outcome of pain relief was analyzed with Denis' pain scale (Table 2) and neurologic improvement was analyzed with Frankel Scores[6] pre and post operation. We also investigated the operation time, blood losses, and complications during the peri-operative period. This study was approved by the Ethics Committee of National Cancer Center, Japan.

2.2. Operation procedure

Operation was performed with patient at a prone position on radiolucent Jackson table under general anesthesia. The fixation of pedicle screws/hooks and rods were performed with minimal invasive surgery. Open operations were performed only for better vision of decompression. For direct posterior decompression, the involved vertebra was identified by X-ray, and then a midline incision was made depending on the affected vertebra. For those cases that have been given radiotherapy before, the incision was modified to avoid the previously irradiated skin by angling the incision towards the lateral to decrease the occurrence of necrosis. Decompression was routinely performed by transpedicular vertebrectomy on the affected vertebra. If it is necessary, the exiting nerve root, transversing nerve root, and adjacent dural sac were also decompressed. Electrocoagulation was always used to stop bleeding during the procedure. To protect paraspinal musculature, pedicle screws/hooks were placed percutaneously using 2-D fluoroscopic guidance. Rod was inserted percutaneously. Crosslinks, if necessary, were installed at the decompression level. Generally, the pedicle screw fixations were placed at "two above, two below" (Fig. 1). More fixations were given to the cases with definite instability in the spine or with an aggressive tumor. We routinely placed a vacuum drainage tube for 2–3 days. The incisions were closed by layers.

Table 2
Denis' pain scale.

Grade	Criteria
1	No pain
2	Occasional, minimal pain; no need for medication
3	Moderate pain, occasional medication, no interruption of ADLs
4	Moderate to severe pain, frequent medication, significant change in ADLs
5	Constant or severe incapacitating pain, chronic medication

ADL, activities of daily living.

2.3. Post operation management

Antibiotics were used until the drainage tube was removed. Nonopioids or opioids were administrated to treat pain right after surgery. Early ambulation with or without help was encouraged if the neurologic condition permitted. No patients required a brace after surgery.

2.4. Statistical analysis

Statistical analysis was performed using SPSS V11.0 (SPSS, Chicago, IL). The Chi-square test was used to compare the difference in Denis' Pain scores and Frankel scores pre- and post-operation. A $p < 0.05$ was considered statistically significant.

Table 1
Patients' data.

Patient no.	Age (year)	Sex	PT	Involved site	Fixation segments	DOF (month)	CPS	TPS	OT (minute)	BL (ml)	DPS		FS	
											Pre-op	Post-op	Pre-op	Post-op
1	62	M	Hepatocellular cancer	T10,12, L1,2	T3–L3	12	DOD	8	229	980	*4*	*4*	D	E
2	72	M	Renal cell cancer	L3	T4–L5	12	DOD	7	375	1614	*4*	*4*	D	C
3	57	M	Leiomyosarcoma	L2,L3	T5–L4	19	DOD	5	300	1553	4	3	D	E
4	71	M	Uncertain location adenocarcinonma	L2,L3	T6–L5	4	DOD	6	397	519	4	3	D	E
5	45	F	Breast cancer	T4,T5	T2–L4	3	DOD	6	289	3253	4	3	B	C
6	74	F	Colon cancer	T9,T10,T11	T6–L2	16	DOD	5	335	884	4	2	C	D
7	54	F	Colon cancer	T8,T9	T4–L3	4	AWD	5	450	1472	4	3	C	D
8	69	M	Uncertain location adenocarcinonma	Multiple	T7–L2	20	AWD	5	250	498	3	2	C	E
9	48	M	Colon cancer	L2,L3	T9–L5	4	DOD	7	250	797	4	3	C	D
10	41	M	Colon cancer	L1,L2	T10–L3	3	DOD	7	264	1504	4	3	C	D
11	48	F	Renal cell cancer	T12,L1	T4–L4	3	DOD	6	180	348	4	3	C	D
12	58	M	Prostate cancer	L1,L3	T8–S1	11	AWD	3	396	523	3	2	C	E
13	64	F	Colon cancer	T3–7	T1–T10	10	DOD	8	350	2383	4	3	C	D
14	61	M	Renal cell cancer	T12,L2	T6–L5	11	AWD	6	391	1945	*3*	*3*	C	E
15	61	F	Breast cancer	T10,T11	T6–L2	43	AWD	4	301	293	4	3	C	E
16	67	F	Thyroid cancer	C4,C6	C3–T3	10	AWD	3	328	635	*3*	*3*	B	D
17	64	M	Lung cancer	T3–7	T1–T5	12	AWD	7	228	540	*3*	*3*	C	D
18	65	F	Renal cell cancer	C6	C3–T4	12	DOD	6	353	1135	4	3	*B*	*B*
19	65	M	Uncertain location adenocarcinonma	T8	T3–T12	12	DOD	7	410	830	*4*	*4*	*C*	*C*
20	45	F	Colon cancer	T2	T1–T5	26	DOD	5	300	1513	4	3	C	E
21	32	M	Acute lymphoblastic leukemia	T10,T12	T3–L4	36	AWD	4	360	721	3	2	*E*	*E*
22	55	M	Colon cancer	T11	T8–L3	4	DOD	5	255	341	4	3	*C*	*C*
23	62	M	Osteosarcoma	T9,T10,T11	T4–L2	17	DOD	6	605	1223	*4*	*4*	*C*	*C*
24	53	F	Colon cancer	T12	T9–L3	5	DOD	7	260	297	*3*	*3*	C	D
25	51	M	Prostate cancer	T6	T3–T9	33	DOD	3	255	377	4	3	C	E

Italics indicates a statistical difference of $p < 0.05$ between pre- and post- operation.
PT, primary tumor; DOF, duration of follow-up; CPS, current patients status; TPS, Tomita prognostic score; OT, operation time; BL, blood loss; DOD, dead of disease; AWD, alive with disease. DPS, Denis' pain scale; FS, Frankel scores.