Clinical Neurology and Neurosurgery 181 (2019) 112–118

Contents lists available at ScienceDirect

Clinical Neurology and Neurosurgery

journal homepage: www.elsevier.com/locate/clineuro

Effect of combined treatment including surgery and postoperative adjuvant therapy on spinal metastases of Tomita type 7

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A R T I C L E I N F O

Keywords:
Spinal metastases
Tomita type 7
Palliative surgery
Tokuhashi score

A B S T R A C T

Objectives: Identify the efficacy of multidisciplinary treatment including palliative spinal surgery on patients with Tomita type 7 spinal metastases.

Patients and methods: A retrospective analysis of surgery treated spinal metastatic patients from January 2013 to December 2016 in Tianjin Medical University Cancer Institute and Hospital were performed. Surgical procedures and intraoperative parameters and postoperative adjuvent treatments were studied. Patients' demographic characteristics and medical conditions including paralysis statues, quality of life and pain levels and postoperative survival time were identified.

Results: 50 patients were identified with mean age at the time of surgery of 57.68 years old (range 27–78 years). The mean Tokuhashi score was 8.48 and the spinal instability neoplastic score (SINS) averaged at 10.52 points. 48 patients (96%) encountered epidural spinal cord compression. Kaplan-Meier method determined median postoperative survival time was 12.00 months (95% CI: 7.05–16.95 months). The mean score of visual analogue scale (VAS) decreased from 7.66 preoperatively to 1.96 postoperatively. The Frankel scale was improved by at least one grade in 47 patients. Patient's quality of life showed significant improvements.

Conclusion: Multidisciplinary treatment including palliative spinal surgery was associated with alleviating pain, improving neurologic function and quality of life in patients with Tomita type 7 spinal metastases.

1. Introduction

Spine is one of the most frequent metastatic sites for malignant tumors. It concerns in 70% of all bone metastatic patients [1]. Therefor surgeries for metastatic spinal tumors had also been extensively developed. The classic surgical classification of spinal metastases has been proposed as early as in 1994 by Tomita [2] to provide a better reference to the identification of different types of spinal diseases. Spine lesions were divided into 7 types by this classification in the basic patterns of longitudinal and horizontal spread of tumors, and surgical suggestions were proposed for some certain types [3].

Metastatic lesions of spinal metastases of Tomita type 7 are characterized by multiple involvement and skipping shots, and usually affect more than 2 spinal segments, which are more prone to pathological fractures and more likely to cause instability of the spine. Tomita clarified that operation is obviously not indicated in spinal metastases of Tomita type 7 [2]. In addition, effective surgical fixation is even harder to achieve with such distribution of lesions of jumping features. All the patients enrolled in this study had multiple spinal metastases, and most were accompanied by bone metastases from other sites. We performed surgical treatment on the main vertebral lesions in which the symptoms are generated. As we know, there is currently no literature specially focus on the study of multidisciplinary treatment of Tomita type 7 spinal metastases.

The life expectancy of patients with spinal metastases is very limited and varied in many factors such as the number and type of primary tumors and nature of metastatic lesions. Patients gradually develop symptoms of pain, neurological dysfunction or paralysis, and eventually affect activities of daily life. Patients could turn to chemotherapy, radiotherapy [4], minimally invasive surgery [5] or open surgery such as en bloc spondylectomy [2,6] for help. Therapeutic decision making in patients with such a short life expectancy requires consideration of the risk of complications, expected benefits, and medical costs. So it is particularly important to improve patients' quality of life with an effective treatment strategy. The primary purpose of palliative surgical treatment is exactly to improve patients' quality of life. Goals of such

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https://doi.org/10.1016/j.clineuro.2019.04.007
Received 10 December 2018; Received in revised form 4 January 2019; Accepted 11 April 2019
Available online 13 April 2019

surgeries include: reducing pain, maintaining or reconstructing spinal stability and restoration of nerve function [7,8]. Performance of palliative open surgery could accomplish decompression, internal fixation vertebroplasty under a direct vision and provide strong stability with a relatively lower rate of complications. However, the strategies and outcomes of palliative surgery have not been well established in spinal metastasis of Tomita type 7 population.

The objective of this study is to outline the technical feasibility, safety and outcomes of palliative decompression surgery with instrument fixation and in some cases intraoperative vertebroplasty for Tomita type 7 spinal metastasis patients.

2. Patients and methods

2.1. Patient population

We retrospectively studied our institutional database for patients who underwent palliative spine surgery from January 2013 to December 2016. A total of 50 patients were identified. Approval of hospital and institutional review board was obtained before acquiring and analyzing patients information from our institutional database.

The inclusion criteria were (1) adult patients with a diagnosis of Tomita type 7 spinal metastatic tumors; (2) accurate vertebral lesion generating spinal compression symptoms or pain could be defined. Patients with severe cardiopulmonary dysfunction or cerebrovascular disease who can't withstand risks of anesthesia or surgery were excluded. Demographic information, presenting symptoms, and radiographic data along with operation parameters were reviewed. Regular outpatient or telephone follow-up were performed on all patients. And the last follow-up evaluation was in June 2018.

2.2. Treatment strategies

In this study, all patients accomplished preoperatively plain radiographs, computed tomography (CT) and/or magnetic resonance imaging (MRI) of the locally affected segment of the spine. Selected systemic examinations were also done to identify the primary disease and other metastases. Bone scan could help to detect other bony secondary tumors, and 18F-FDG PET-CT scans was useful in staging systemic disease. Postoperative imaging was also regularly used to assess the integrities of spinal implants.

The indications for palliative surgery of metastatic spinal tumor were (1) intractable pain due to a unstable spine or a potentially unstable spine defined by the spinal instability neoplastic score (SINS) that is resistant to nonsurgical treatment; (2) progressive neurologic dysfunction or spinal paralysis especially for motor dysfunction; (3) metastatic disease originated from a radiation-resistant tumor such as kidney cancer or thyroid cancer. The contraindications were (1) cases indicated for total en bloc spondylectomy; (2) intolerance to surgery or anesthesia; (3) reduced willingness to live.

For cervical metastatic disease, we performed anterior tumor resection with internal fixation of titanium plate, while for thoracic and lumbar spine disease, conventional posterior decompression with internal transpedicular screws and rods fixation and intraoperative vertebroplasty were performed (Fig. 1).

2.3. Items and indexes

Preoperative items and surgical procedure and postoperative outcomes were reviewed and evaluated both clinically and radiologically. Evaluation of preoperative items include:(1) the grade of paralysis on Frankel scale; (2) VAS scores for pain intensity; (3) the Tokuhashi scores to indicate life expectancy; (4) SINS indicating spine instability; (5) the epidural spinal cord compression scale (ESCCS) for nerve compression; (6) the scores of each domain in EORTC QLQ-C30 (version 3.0) questionnaire.

Indexes of outcome include: (1) operation details including number of spinal segment fused, operation time, blood loss, the average amount of cement used in a single vertebrae and perioperative complications; (2) VAS scores at 2 weeks after surgery; (3) grade of Frankel scale at 2 weeks after surgery; (4) postoperative changes at 2 weeks after surgery in EORTC QLQ-C30 (version 3.0) for QOL; (5) postoperative survival time; (6) multidisciplinary therapy including chemotherapy, radiotherapy, and bone-modifying agents after surgery, appropriate adjuvant therapy was given when it is necessary.

2.4. Statistical analysis

Statistical analyses were performed using SPSS 24.0 version software for Windows (IBM SPSS Inc.). Descriptive statistics were used to analyze the clinical information, demographic factors and other test data. Preoperative and postoperative scores of VAS /Frankel scale/ EORTC QLQ-C30 were compared using a paired *t*-test Survival curve were calculated by the Kaplan-Meier method. A two-tailed p value < 0.05 was considered statistically significant.

3. Results

3.1. Baseline characteristics of patients

There were 31 male patients (62%) and 19 female patients (38%) in this study. The average age was 57.68 when they got the treatment of surgery. Primary tumor sources were lung in 23 patients (46%), prostate in 6 (12%), breast in 5 (10%), kidney in 3 (6%), colon or rectum in 3 (6%), malignant melanoma in 2 (4%), cervix in 1 (2%), soft tissue sarcoma in 3 (6%) (including synovial sarcoma, leiomyosarcoma, and angiosarcoma), thyroid in 1 (2%), ureter in 1 (2%). Primary tumor were unknown in 2 patients (4%). The main lesion was in the cervical spine in 5 patients (10%), each of them had only one segment involved. Main lesion was in thoracic spine in 27 patients (54%), 20 of them had single segment involved; 4 patients had two segments involved, and the other 3 patients had three segments involved, respectively. For 2 (4%) patients with thoracolumbar spine disease, main lesions were all located in 2 segments, being T12 and L1 segments. The other 16 (32%) patients had lumbar spine disease, 11 of them had single segment involved; and 5 patients had two segments involved, respectively. With regard to postoperative adjuvant therapy, 31 patients (62%) received adjuvant chemotherapy, and radiotherapy was performed in16 patients (32%), while a bone-modifying agent was administered in all patients (Table 1).

Results of preoperative evaluation items: for Tokuhashi score, the overall mean score was 8.48. There were 27 patients (54%) scored 0–8, with a life expectancy < 6 months; 17 patients (34%) scored 9–11, indicating life expectancy ≥ 6 months; and scores12–15, in 6 (12%) patients with life expectancy ≥ 1 year. For evaluation of SINS, there were 3 patients (6%) evaluated as spinal instability with scores of 0-6. And 7–12, threat of instability, in 37 (74%). 10 patients (20%) in 13–18, indicating that the spine was stable. The mean preoperative SINS for spine instability was 10.52. All the patients showed obvious spinal cord compression symptoms with severe ESCCS grade. 2 (4%) patients ranked in grade 2, and 48 (96%) ranked in grade 3 indicating that marked compression of spinal nerve root and radicular pain has turn up. For postoperative items, the median postoperative survival time was 12.00 months (95% confidence interval 7.05–16.95). (Fig. 2)

For Frankel scale, A in 2 patients (4%), B in 2 (4%), C in 3(6%), D in 43(86%), and none patient ranked in E, preoperatively. Paralysis was improved by at least 1 grade postoperatively for most patients and grade E was maintained in 47 (94%) (Table 2). The grade was C or lower before surgery in 7 patients (14%), while the number after surgery was 4 (8%). No patient encountered progress in paralysis. Statistically significant reductions in VAS scores were also noted preoperatively and postoperatively (7.66 ± 1.349 vs. 1.96 ± 1.557,

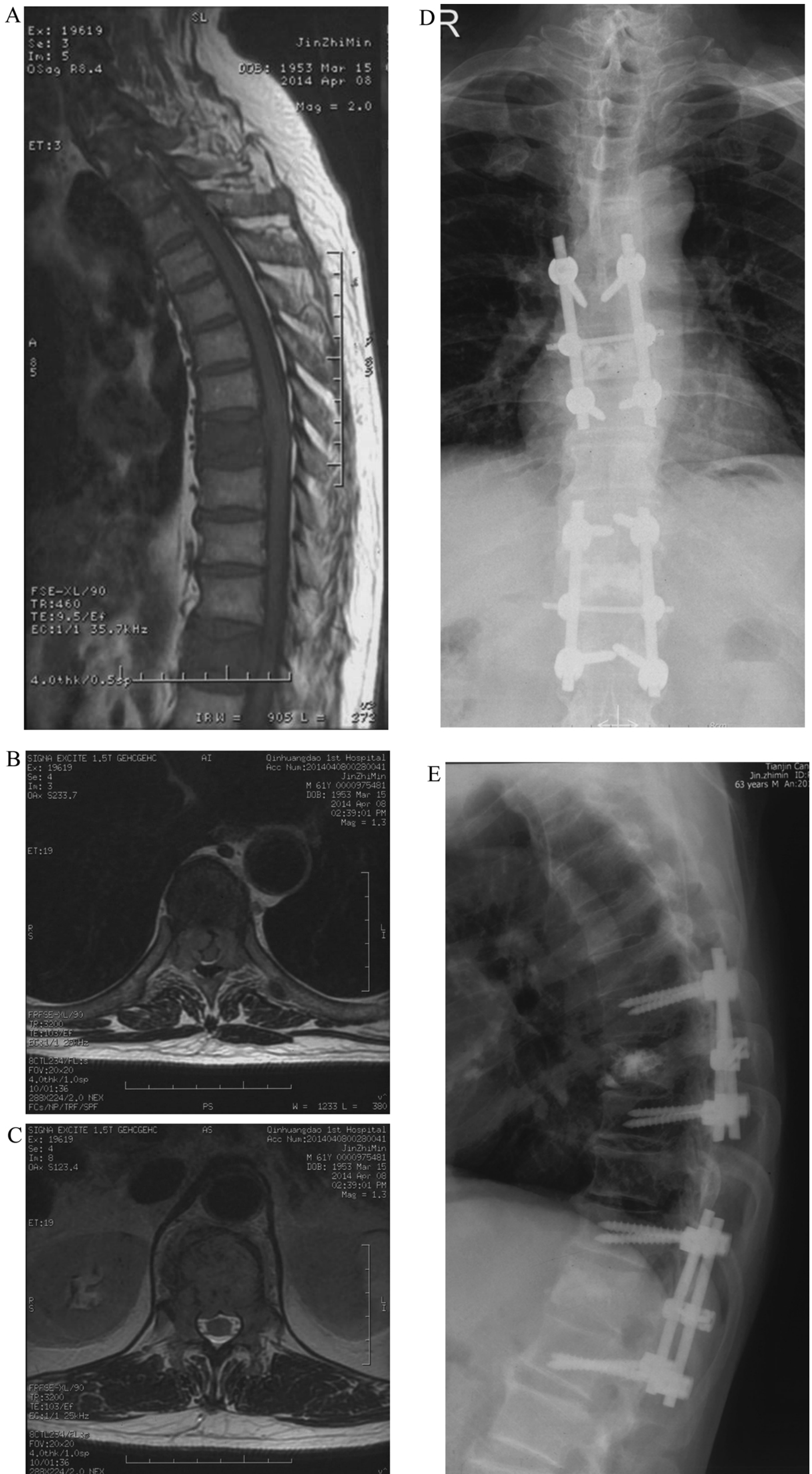

Fig. 1. A 61-year-old male presented with severe thoracic and lumbar back pain and a suddenly incomplete paraplegia was diagnosed with prostate cancer spine metastases and treated with palliative tumor resection, posterior decompression and internal fixation with transpedicular screws, rods and intraoperative vertebroplasty. Preoperative sagittal T1-weighted MRI showing vertebral bone destruction of T8 and T12(A); preoperative T2-weighted MR plane image showing significantly spinal cord compression at T8 (B) and T12 (C); postoperative anteroposterior(D) and lateral(E) spinal radiography revealed main lesions were effectively fixed.

Table 1
Baseline Information of Patients.

Variable	Value
Total number of patients (n)	50
Age at surgery, mean (range), years	57.68 (27–78)
Sex, n (%)	
Female	19 (38%)
Male	31 (62%)
Primary tumor diagnosis, n (%)	
Lung	23 (46%)
Prostate	6 (12%)
Breast	5 (10%)
Kidney	3 (6%)
Colon and rectum	3 (6%)
Myeloma	2 (4%)
Cervix	1 (2%)
Soft tissue Sarcoma	3 (6%)
Thyroid	1 (2%)
Ureter	1 (2%)
Unknown	2 (4%)
Main level of tumors, n (%)	
Cervical	5 (10%)
Thoracic	27 (54%)
Thoracolumbar	2 (4%))
Lumbar	16 (32%)
Preoperative Visual analogue scale (range)	7.66 (5-10)
Postoperative Visual analogue scale (range)	1.96 (0-9)
Preoperative Tokuhashi score, n (%)	
0–8	27 (54%)
9–11	17 (34%)
12–15	6 (12%)
Spinal instability neoplastic score, n (%)	
0–6	3 (6%)
7–12	37 (74%)
13–18	10 (20%)
Epidural spinal cord compression scale, n (%)	
0	0 (0%)
1	0 (0%)
2	2 (4%)
3	48 (96%)
Total number of patients	50 (100%)
Postoperative adjuvant therapy, n (%)	
Chemotherapy	23 (46%)
Radiotherapy	16 (32%)
Endocrine therapy	3 (6%)
Immunity therapy	2 (4%)
Targeted therapy	8 (16%)
Bone-modifying agent therapy	50 (100%)

Table 2
Neurological Recovery on Frankel scale.

Frankel scale	Preoperative cases	Postoperative cases				
		A	B	C	D	E
A	2	0	1	1	0	0
B	2	0	0	2	0	0
C	3	0	0	1	1	1
D	43	0	0	0	2	41
E	0	0	0	0	0	0
Total	50	0	1	4	3	42

$p < 0.01$). As for quality of life, 14 of the total 15 domains of EORTC QLQ-C30 (version 3.0) have significantly improved, the average preoperative and postoperative scores was showed in Table 3.

3.2. Surgical procedure

For 5 patients (10%) with main lesion located in a single cervical spine segment, we performed anterior cervical tumor resection with internal fixation of titanium plate, the main lesion and conventional posterior decompression with internal fixation and intraoperative vertebroplasty performed in 45 patients (90%). The average operation time was 225.88 min (range, 120–500 min), with an average fusion segments number of 3.82 (range, 3–9); and the mean intraoperative blood loss was 886 mL (range, 50–7000 mL), the mean volume of bone cement injected was 3.49 mL (range, 1.50–5.00 mL) (Table 4).

3.3. Perioperative complications

Perioperative complications included massive bleeding ≥ 3000 mL during surgery in 3 patients (6%), however no perioperative death occurred. Postoperative wound dehiscence occurred in 1 patient (2%) and incision infection in 1 patient (2%), they were well treated with debridement and regular dressing changing and healed properly. One patient (2%) developed thrombosis of deep veins, and was given inferior vena cava filter (Table 4).

4. Discussion

Recent advances in diagnosis and management of tumor have greatly increased the duration and quality of life of patients with spinal metastases [9]. Laufer et al [10] proposed that a palliative surgery

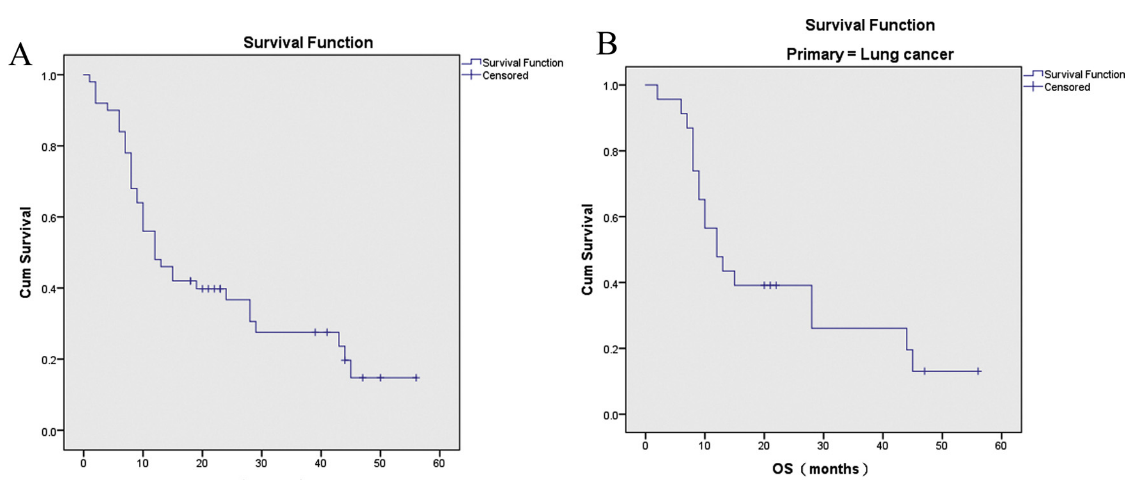

Fig. 2. Kaplan-Meier Curves for Survival Time.
Kaplan-Meier curve for postoperative survival time of all patients. The median survival time was 12.0 months with a 95% confidence interval of 7.05–16.95 (A); and Kaplan-Meier curve for postoperative survival time of patients with primary lung cancer. The median survival time was 12.0 months with a 95% confidence interval of 7.31–16.70 (B).

Table 3
Scores for the EORTC QLQ-C30 Questionnaire.

Domains	Preoperative scores		Postoperative scores		P value	meanings
	average	median	average	median		
Quality of life	36.2	33.3	83.0	83.3	p < 0.001	improved
Physical	17.6	6.7	74.9	86.7	p < 0.001	improved
Role function	14.0	0.0	76.0	91.7	p < 0.001	improved
Emotional	42.3	41.7	70.5	75.0	p < 0.001	improved
Cognitive	53.7	50.0	82.0	83.3	p < 0.001	improved
Social global	8.3	0.0	84.3	100.0	p < 0.001	improved
Fatigue	75.8	77.8	26.2	22.2	p < 0.001	improved
Nausea	7.7	0.0	3.0	0.0	p = 0.003	improved
Pain	95.0	100.0	22.7	16.7	p < 0.001	improved
Dyspnoea	23.3	0.0	5.3	0.0	p < 0.001	improved
Sleep disturbance	79.3	83.3	28.0	33.3	p < 0.001	improved
Appetite loss	26.7	33.3	11.3	0.0	p < 0.001	improved
Constipation	88.0	100.0	28.0	33.3	p < 0.001	improved
Diarrhoea	3.3	0.0	2.0	0.0	p = 0.157	insignificant
Financial impact	44.0	33.3	14.0	0.0	p < 0.001	improved

Abbreviations: EORTC QLQ-C30, the response categories of the physical functioning scale from a dichotomous response to a four categories system revised by study group on The Quality of Life of European Organization for Research and Treatment of Cancer.

Table 4
Intraoperative clinical parameters and perioperative complications of all patients.

Variable	Value
Intraoperative parameters	
Number of levels fused, mean (range)	3.82(3-9)
Operation time, mean (range), (min)	225.88(120-500)
Blood loss, mean (range), (mL)	886(50-7000)
Bone cement injection, mean (range), (mL)	3.49(1.50-5.00)
Perioperative complications, n (%)	
Massive bleeding (> 3000 mL)	3(6%)
Poor healing of the incision	1(2%)
Infection	1(2%)
Deep vein thrombosis	1(2%)

could in return provide patients with further opportunities of continuing systemic therapy. Our previous study of lung cancer spinal metastatic patients treated with surgery combined radiotherapy has reported a mean survival being 10.6 months [11]. In our present study, all patients have successfully performed surgery with no intraoperative neurological or important vascular injuries. A survival analysis of the 50 patients was acquired: the 6-, 12-, and 18-month overall survival rate at the last follow-up was 90%, 56%, and 42%, respectively, with a median survival time of 12.0 months. Statistically significant reductions in the visual analogue score were noted preoperatively and postoperatively from 7.66 to 1.96 *($p < 0.01$)*. The paralysis status evaluated by Frankel scale was greatly improved as well as health conditions and quality of daily life evaluated by EORTC QLQ-C30 (version 3.0).

Previous studies have also shown similar outcomes that patients with spinal metastases could markedly benefited from surgical treatment [12,13].Early studies by Cho showed that palliative surgery for spinal metastases could relieve pain and improve neurological symptoms with a mean postoperative survival time of 8.9 months [14]. Hiroshi Uei et al [4] reported that a median postoperative survival time of 12.0 months (95%confidence interval 2.4–21.5) among 55 spinal metastatic patients with the modified Frankel scale improved in 63.6% patients, and VAS scores decreased from 4.9 to 0.9 preoperatively and postoperatively. In a France cohort consisted of 319 patients, Sailhan [15] reported that 69.4% of patients had achieved Frankel Grade E and pain levels had been significantly reduced from a preoperative VAS scores of 4.6 to 2.4 at 6-months postoperatively ($p < 0.001$).The postoperative median overall survival time increased to among 10–22 months, and the symptom of pain alleviated, patients' neurological function and quality or activities of daily living improved. In addition, one patient in our study had accidentally died in a car accident 1 month after his surgery, which could have reduced the overall survival of the present study slightly.

For details of effect on Frankel scale, we have achieved obvious improvement on patients' neurological function: 94% of patients had at least 1 Frankel grade increased after surgery. None of 50 patients had Frankel grade E before surgery, while the number of patients with this grade increased to 42 (84%) after surgery. Prolonged ambulation and neurologic symptom relief serve as an important surgical goal which remarkably decrease unpleasant feelings with daily activities. This is particularly important since the nature of most treatments is palliative. However, we noted 3 non-ambulatory patients (6%) whose paralysis status were just stable but not significantly improved. One of the three patients classified both grade “C” pre-and postoperatively by Frankel scale, while the other two patients were both stably ranked grade “D”. This was in accordance with the opinion that the improvement rate was less significant for patients who were non-ambulatory before surgery compared to those who were ambulatory [16]. Among patients with a Frankel grade less than E, Chong et al [17] reported a 11% (2 of 19 patients) improvement rate of at least one grade on the Frankel scale for non-ambulatory patients, 43% (19 of 44 patients) in the ambulatory group and 33% (21 of 63 patients) overall. In another aspect, radiotherapy is reported effective in improving neurological function and in preservation of ambulation of spinal metastatic disease [18].

As for changes in quality of life, we found postoperative states of physical, role, cognitive and emotional functioning and global health status and most symptoms have significantly improved. The results were consistent with Gerald's prospective study on 118 patients indicating that highly significant improvement in functioning domains and global health status, pain symptoms and overall quality of life postoperatively [19]. In recent years, quality of life was regarded as one of key parameters like survival or pain by which surgery for spinal metastases was judged, and there was increasing number of data on patients' quality of life reported. Falicov et al [20] reported on 85 patients whose pain and EORTC QLQ-C30 questionnaire results had been improved at 1 year after surgery, and Bernard et al [21] described surgical patients with improvements in the assessment of EORTC QLQ-C30 questionnaire results and ability to walk. Indeed, the quality of life may be an essential parameter for measurement of patients' surgery outcomes because it could provide surgeons with a comprehensive understanding of patients' conditions.

The amount of blood loss is a crucial parameter to evaluate safety of surgery, and it is affected by many factors including primary tumor type, surgical procedure, surgeon's preference and skills and the use of hemostatic equipment [22]. Outcomes in Fahed's study demonstrated that the emergency nature of the surgery were associated with increased blood loss because of the wide decompression of neural elements, wide skin incision and muscle desinsertion [23]. However the primary tumor type is of most importance among all these factors as we know [24]. In this study, 3 patients had intraoperative blood loss exceeding 3000 mL, and the primary tumors were malignant melanoma, lung cancer, and renal clear cell carcinoma respectively. The average blood loss during operation was 886 mL (range,50–7000 mL). But no perioperative deaths occurred. Similar results were also found in Dong's study [25]: 26 patients accepted palliative surgery via posterior decompression and fixation combined with intraoperative vertebroplasty, the mean blood loss was 659 mL (range, 350–2500 mL). Another varied result had also been reported with the mean blood loss in Cho's study being 1400 mL [14].

A relatively larger number of lung cancer spinal metastatic patients were recruited in this study (n = 23,46%). According to Arrigo's study published in 2011, 20% of 200 surgically treated spinal metastasis patients at Stanford Hospital were derived from lung cancer while 11.5% were derived from breast cancer [26]. Then in 2013, another larger cohort of 2321 patients reported by Morgen also declared that 20.98% of their patients were originated from lung cancer and 19.55% from breast cancer [27]. In this study, patients with metastatic spinal disease originated from lung cancer and breast cancer were 23 (46%) and 5 (10%), respectively. We noticed that the higher proportion of surgical intervention had been performed for lung cancer derived spinal metastasis patients of Tomita type 7 compared with breast cancer, and most of them could benefited from surgery. The median postoperative survival time of our 23 patients was 12.0 months (95%confidence interval 7.31–16.70), similar to that of Deberne's study of patients with lung cancer bone metastases achieving a median survival time of 13.4 months [28]. Excepted for surgery, improvements of survival and quality of life of lung cancer-derived spinal metastasis were also attributed to the prevalence of molecule-targeted agents such as TKIs from 2002 onwards [29].

The prognostic prediction scoring system designed by Tokuhashi et al [30] and it's modified vision were widely used to select the optimal treatment strategy for spinal metastases. We applied Tokuhashi scoring system to assess the life expectancy of all patients in the present study. In our study, 27 (54%) patients scored 0–8, 17 (34%) scored 9–11, and only 6 (12%) scored 12–15, with predicted life expectancy of less than 6 months, between 6–12 months, and greater than 12 months, respectively. Yet the actual post-treatment survival times for each group were 10 (range, 2–47) months, 15 (range,1–56) months and 26 (range,8–43) months respectively. Given the outcomes mentioned above, we doubt that the ability and accuracy of modified Tokuhashi scoring system for predicting life expectancy has been significant decreased in patients with spinal metastases. Greater discrepancies have also been noted between predictions of Tokuhashi score and actual survival times in other analysis of prognosis for patients with metastatic spine tumors who had accepted spine surgery [31,32].Therefore, more effective prognostic evaluation systems are required and their efficacy needed to be reviewed in larger cohorts [33].

Our study and analysis on patients' survival time, symptoms and quality of life offered more experience on management of spinal metastases. The limitations of this study include the retrospective nature of this study design, and single-center study with a relatively small population sample size. In another aspect, spinal metastasis of patients enrolled in this study were generated from multiple primary tumor types, which lead to a great heterogeneity in prognostic status but hard to analyze because each type contains only very small number of patients. A multicenter study with a large amount of population may reveal additional information on the management of spinal metastatic disease.

5. Conclusions

Spinal metastases of Tomita type 7 is intractable to management. Palliative decompression with effective stabilization can achieved effective clinical outcomes with a low rate of complication. The pain was significantly reduced, the neurological function and quality of life were improved. In general, multidisciplinary therapies including palliative open surgery and postoperative adjuvant therapy is a reliable approach for patients with Tomita 7 spinal metastases.

Funding

This research was supported by the National Nature Science Foundation of China (Nos.81602363, 81702161, 81872184).

Conflict of interest

The authors declare that they have no conflict of interest.

Acknowledgement

The authors express thanks to all the patients and their families for providing information and agreeing to the analysis.

References

[1] G.M. Quan, J.-M. Vital, V. Pointillart, Outcomes of palliative surgery in metastatic disease of the cervical and cervicothoracic spine, J. Neurosurg. Spine 14 (5) (2011) 612–618.
[2] K. Tomita, N. Kawahara, H. Baba, H. Tsuchiya, S. Nagata, Y. Toribatake, Total en bloc spondylectomy for solitary spinal metastases, Int. Orthop. 18 (5) (1994) 291–298.
[3] K. Tomita, N. Kawahara, T. Kobayashi, A. Yoshida, H. Murakami, T. Akamaru, Surgical strategy for spinal metastases, Spine 26 (3) (2001) 298–306.
[4] H. Uei, Y. Tokuhashi, M. Maseda, M. Nakahashi, H. Sawada, E. Nakayama, H. Soma, Clinical results of multidisciplinary therapy including palliative posterior spinal stabilization surgery and postoperative adjuvant therapy for metastatic spinal tumor, J. Orthop. Surg. Res. 13 (1) (2018) 30–37.
[5] T. Stefano, P. Alfredo, C. Francesco, G. Maddalena, P. Andrea, V. Veronica, F. Alessandra, S. Isabella, R. Laura, Kyphoplasty with purified silicone VK100 (Elastoplasty) to treat spinal lytic lesions in cancer patients: a retrospective evaluation of 41 cases, Clin. Neurol. Neurosurg. 171 (2018) 184–189.
[6] P. Liu, L. Jiang, Y. Liang, H. Wang, H. Zhou, X. Li, H. Lin, X. Zhou, J. Dong, Are older patients with solitary spinal metastases fit for total en-bloc surgery? Clin. Neurol. Neurosurg. 170 (2018) 20–26.
[7] A.C. Berger, Introduction: role of surgery in the diagnosis and management of metastatic cancer, Semin. Oncol. 35 (2) (2008) 98–99.
[8] I. Feiz-Erfan, L.D. Rhines, J.S. Weinberg, The role of surgery in the management of metastatic spinal tumors, Semin. Oncol. 35 (2) (2008) 108–117.
[9] T. Liu, S. Wang, H. Liu, B. Meng, F. Zhou, F. He, X. Shi, H. Yang, Detection of vertebral metastases: a meta-analysis comparing MRI, CT, PET, BS and BS with SPECT, J. Cancer Res. Clin. Oncol. 143 (3) (2017) 457–465.
[10] I. Laufer, D.M. Sciubba, M. Madera, A. Bydon, T.J. Witham, Z.L. Gokaslan, J.-P. Wolinsky, Surgical management of metastatic spinal tumors, Cancer Control 19 (2) (2012) 122–128.
[11] C. Zhang, G. Wang, X. Han, Z. Ren, J. Duo, Comparison of the therapeutic effects of surgery combined with postoperative radiotherapy and standalone radiotherapy in treating spinal metastases of lung cancer, Clin. Neurol. Neurosurg. 141 (2016) 38–42.
[12] X. Wu, M. Tan, Y. Qi, P. Yi, F. Yang, X. Tang, Q. Hao, Posterior decompression and occipitocervical fixation followed by intraoperative vertebroplasty for metastatic involvement of the axis, BMC Musculoskelet. Disord. 19 (1) (2018) 11.
[13] N.A. Quraishi, G. Arealis, K.M. Salem, S. Purushothamdas, K.L. Edwards, B.M. Boszczyk, The surgical management of metastatic spinal tumors based on an Epidural Spinal Cord Compression (ESCC) scale, Spine J. 15 (8) (2015) 1738–1743.
[14] D.-C. Cho, J.-K. Sung, Palliative surgery for metastatic thoracic and lumbar tumors using posterolateral transpedicular approach with posterior instrumentation, Surg. Neurol. 71 (4) (2009) 424–433.
[15] F. Sailhan, S. Prost, F. Zairi, O. Gille, H. Pascal-Mousselard, S. Bennis, Y.-P. Charles, B. Blondel, S. Fuentes, Retrospective multicenter study by the French Spine Society of surgical treatment for spinal metastasis in France, Orthop. Traumatol. Surg. Res. 104 (5) (2018) 589–595.
[16] H. Hirabayashi, S. Ebara, T. Kinoshita, Y. Yuzawa, I. Nakamura, J. Takahashi, M. Kamimura, K. Ohtsuka, K. Takaoka, Clinical outcome and survival after palliative surgery for spinal metastases: palliative surgery in spinal metastases, Cancer 97 (2) (2003) 476–484.
[17] S. Chong, S.-H. Shin, H. Yoo, S.H. Lee, K.-J. Kim, T.-A. Jahng, H.-S. Gwak, Single-stage posterior decompression and stabilization for metastasis of the thoracic spine:

prognostic factors for functional outcome and patients' survival, Spine J. 12 (12) (2012) 1083–1092.
[18] P.S. Sørensen, S.E. Børgesen, K. Rohde, B. Rasmusson, F. Bach, T. Bøge-Rasmussen, P. Stjernholm, B.H. Larsen, N. Agerlin, F. Gjerris, Metastatic epidural spinal cord compression. Results of treatment and survival, Cancer 65 (7) (1990) 1502–1508.
[19] G.M. Quan, J.-M. Vital, N. Aurouer, I. Obeid, J. Palussiere, A. Diallo, V. Pointillart, Surgery improves pain, function and quality of life in patients with spinal metastases: a prospective study on 118 patients, Eur. Spine J. 20 (11) (2011) 1970–1978.
[20] A. Falicov, C.G. Fisher, J. Sparkes, M.C. Boyd, P.C. Wing, M.F. Dvorak, Impact of surgical intervention on quality of life in patients with spinal metastases, Spine 31 (24) (2006) 2849–2856.
[21] F. Bernard, J.-M. Lemée, O. Lucas, P. Menei, Postoperative quality-of-life assessment in patients with spine metastases treated with long-segment pedicle-screw fixation, J. Neurosurg. Spine 26 (6) (2017) 725–735.
[22] J.C. Wang, P. Boland, N. Mitra, Y. Yamada, E. Lis, M. Stubblefield, M.H. Bilsky, Single-stage posterolateral transpedicular approach for resection of epidural metastatic spine tumors involving the vertebral body with circumferential reconstruction: results in 140 patients, J. Neurosurg. Spine 1 (3) (2004) 287–298.
[23] Z. Fahed, V. Marie-Helene, D. Patrick, R. Aboukais, G. Louis, Management of neoplastic spinal tumors in a spine surgery care unit, Clin. Neurol. Neurosurg. 128 (2015) 35–40.
[24] C.J. Griessenauer, M. Salem, P. Hendrix, P.M. Foreman, C.S. Ogilvy, A.J. Thomas, Preoperative embolization of spinal tumors: a systematic review and meta-analysis, World Neurosurg. 87 (2016) 362–371.
[25] L. Dong, M. Tan, D. Wu, P. Yi, F. Yang, X. Tang, Q. Hao, Palliative surgery for spinal metastases using posterior decompression and fixation combined with intraoperative vertebroplasty, Clin. Spine Surg. 30 (8) (2017) 343–349.
[26] R.T. Arrigo, P. Kalanithi, I. Cheng, T. Alamin, E.J. Carragee, S.A. Mindea, J. Park, M. Boakye, Predictors of survival after surgical treatment of spinal metastasis, Neurosurgery 68 (3) (2011) 674–681.
[27] S.S. Morgen, C. Lund-Andersen, C.F. Larsen, S.A. Engelholm, B. Dahl, Prognosis in patients with symptomatic metastatic spinal cord compression: survival in different cancer diagnosis in a cohort of 2321 patients, Spine 38 (16) (2013) 1362–1367.
[28] M. Deberne, S. Ropert, B. Billemont, C. Daniel, J. Chapron, F. Goldwasser, Inaugural bone metastases in non-small cell lung cancer: a specific prognostic entity? BMC Cancer 14 (1) (2014) 416–424.
[29] M. Lei, Y. Liu, L. Yan, C. Tang, S. Yang, S. Liu, A validated preoperative score predicting survival and functional outcome in lung cancer patients operated with posterior decompression and stabilization for metastatic spinal cord compression, Eur. Spine J. 25 (12) (2016) 3971–3978.
[30] Y. Tokuhashi, H. Matsuzaki, H. Oda, M. Oshima, J. Ryu, A revised scoring system for preoperative evaluation of metastatic spine tumor prognosis, Spine 30 (19) (2005) 2186–2191.
[31] C. Zoccali, J. Skoch, C.M. Walter, M. Torabi, M. Borgstrom, A.A. Baaj, The Tokuhashi score: effectiveness and pitfalls, Eur. Spine J. 25 (3) (2016) 673–678.
[32] H. Uei, Y. Tokuhashi, Prognostic factors in patients with metastatic spine tumors derived from lung cancer—a novel scoring system for predicting life expectancy, World J. Surg. Oncol. 16 (1) (2018) 131–139.
[33] S.S. Morgen, S. Fruergaard, M. Gehrchen, S. Bjørck, S.A. Engelholm, B. Dahl, A revision of the Tokuhashi revised score improves the prognostic ability in patients with metastatic spinal cord compression, J. Cancer Res. Clin. Oncol. 144 (1) (2018) 33–38.