Original Article

Short-term assessment of functional outcomes and quality of life after thoracic and lumbar spinal metastasis surgery

ABSTRACT

Background: Because of improvements in initial tumor identification and treatment, as well as longer life expectancies, more people are receiving diagnoses for spinal metastases.

Objective: The aim of this study was to assess early functional outcomes and quality of life (QOL) after surgical management of patients with spinal metastases.

Patients and Methods: In this prospective cohort study, a total of 33 patients with thoracic and lumbar spine metastases who underwent surgical management between November 2021 and August 2023 were followed up for 1 year or until death. Oswestry Disability Index and the Eastern Cooperative Oncology Group Performance Status were used for the functional outcome; QOL was assessed using European Quality of Life 5-Dimensions (EuroQOL-5D). Scores were recorded preoperatively, 4 weeks postoperatively, and 6 and 12 months postoperatively.

Results: The mean age was 52.12 ± 13.4 years (range: 23–70 years), 22 (66.7%) were females, and 11 (33.3%) were males. Patients were divided into three groups according to the revised Katagiri score: 12 (36.4%) patients were at low risk (0–3), 18 (54.5%) patients were at intermediate risk (4–6), and 3 (9.1%) patients were at high risk (7–10). The mean survival was 5.44 ± 3.46 months (range 1–13), and there was no perioperative death (within 1 month postoperative). Sixteen (48.5%) patients survived for more than 1 year and 17 (51.5%) patients died from different causes related to the natural history of tumor metastasis.

Conclusion: Following surgical treatment of the spinal metastases, improvements in QoL and functional results were seen in the short-term. For patients with a projected life expectancy of longer than 3 months, surgery is a good alternative.

Keywords: Functional outcome, metastatic spine surgery, quality of life, short-term follow-up, spinal metastases

INTRODUCTION

An increase in the occurrence of bone metastases has been noted, which can be attributed to the global rise in cancer incidence and the higher life expectancy of these individuals.[1,2] After the lung and liver, the bone is the third most common location of metastasis.[3]

Bone metastases, especially those involving the spine, are a major cause of mortality and morbidity and are characterized by poor quality of life (QOL) due to severe and constant pain, poor mobility, pathological fractures, spinal cord compression, bone marrow aplasia, and hypercalcemia.[4]

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All age groups are susceptible to spinal metastases; however, the biggest occurrence happens between the ages of 40 and 65 years.[5]

They can be categorized as extradural or intradural (intramedullary or extramedullary) based on their anatomical position.[5] Up to 95% of spine lesions are extradural lesions, which are further classified as either pure extradural lesions or lesions that originate in the vertebra and then impinge on the thecal sac. Rarely do pure epidural metastases occur.[6] The most frequent location for spine metastases is the thoracic spine (60%–80%), which is followed by the lumbar spine (15%–30%) and the cervical spine (<10%).[7]

These symptomatic spinal lesions may be life-threatening or severely disabling, depending on where they are located. Metastatic spinal cord compression is one of these effects. It is the result of an extradural tumor mass compressing the dural sac, which includes the spinal cord and/or cauda equina, and its contents.[8]

The aim of this study was to assess the early functional outcome and the QOL after surgical management for spinal metastases and identify prognostic factors affecting the outcome of surgery.

PATIENTS AND METHODS

In this prospective cohort study, a total of 33 patients with thoracic and lumbar spine metastases underwent surgical management at Kasr Alainy Hospital, Cairo University, between November 2021 and August 2023, with 1 year of follow-up or until death.

Included were patients above 18 years of age with spinal metastasis (thoracic, lumbar, or sacral), the presence of intractable pain not responsive to nonoperative measures, spinal instability manifested as pathologic fracture or progressive deformity, the presence of clinically significant neural compression, or manifested neurological deficits. Patients with lymphoproliferative disorders (multiple myeloma and lymphoma) were also included due to their similar natural history.

We excluded patients with primary benign and malignant spinal tumors, cervical metastasis, and other pathological fractures in the upper or lower limbs, and patients who were unable to complete the questionnaires (unconsciousness, mental illness, or dementia).

Preoperatively, a full history was taken, and the patient underwent a complete general examination. A detailed neurological examination was performed for all patients, including examination of motor power, sensory examination to light touch and pinprick in different dermatomal distributions, and examination of deep tendon reflexes and rectal sensation and tone.

The routine laboratory tests required for spinal metastasis patients include complete blood count, differential count, coagulation profile, liver functions, kidney functions, erythrocyte sedimentation rate, C-reactive proteins, electrolytes, specific tumor markers, and electrophoresis of serum and urine.

Spine radiographs were obtained to assess the nature of the lesions, whether they were osteolytic, osteosclerotic, or mixed. Magnetic resonance imaging (MRI) of the whole spine was performed to detect the tumor extension into the canal and foramina and to determine the nature of the retro-pulsed fragment in addition to cord and cerebrospinal fluid affection.

Computed tomography (CT) of the whole spine was performed for the patients to gain further information regarding bony effects, potential instability in terms of the percentage of body affected, extent of adverse effects on the end plates, and degree of vertebral collapse.

The extent and severity of the patient's metastatic disease were detected by bone scan, chest CT, abdominal and pelvic CT, or positron emission tomography-CT. If the metastatic workup did not provide the nature of our lesion, a CT-guided core biopsy was performed.

Functional assessment was achieved by:

1. An Arabic version of the Visual Analog Scale (VAS)
2. The Eastern Cooperative Oncology Group (ECOG) was used to assess performance status (PS)[9]
3. Revised Katagiri score for prognosis and fitness for surgery[10]
4. Neurological status was assessed by the American Spinal Injury Association (ASIA) impairment scale
5. Ambulatory status
6. Spinal instability neoplastic score (SINS) for instability[11]
7. Arabic version of the Oswestry Disability Index (ODI)[12]
8. QOL according to the European Quality of Life 5-Dimensions (EuroQOL-5D) Arabic version for Egypt.[13]

Decision-making was individualized to the patient. The feasibility to operate was determined, and then meticulous planning entailed the operation type, resection, decompression, reconstruction, the fixation level, technique, and postoperative adjuvant treatment.

In addition to answering the patients' queries and outlining our surgical objectives, we talked about the risks associated with the operations during the preoperative session. We arrange the procedure if the patient is persuaded of its necessity, goal, and dangers. Before surgery, the patients gave their properly informed written agreement so that they could participate in the study. The specifics of the surgery, such as its advantages and potential dangers, problems, and aftercare guidelines.

The surgical approach, type of operation, indications for surgery, number and location of the metastases (thoracic, lumbar, or sacrum), intraoperative complications, operative time, postoperative complications, urinary sphincter control, length of intensive care unit, total hospital stay, and perioperative death based on the World Health Organization definition (within 30 days of surgery) were recorded. The posterior approach was used in all patients in our study with different techniques and types of resections.

Follow-up data

Clinical follow-up: Pain, disability, and neurological status were assessed at 4 weeks, 6, and 12-month intervals, while radiological follow-up included serial postoperative radiographs and MRI with contrast if needed. Functional status and QOL assessments were performed at 4 weeks, 6, and 12 months postoperatively and the time and cause of death were recorded.

Statistical analysis

SPSS version 28 (IBM Corp., Armonk, NY, USA) was used to code and input the data. The mean, standard deviation (SD), median, minimum, and maximum were used to describe quantitative data, and the count and relative frequency (%) were used for categorical data. Comparisons between quantitative variables were performed using nonparametric Kruskal–Wallis and Mann–Whitney *U*-tests. Individual patient serial measurements were compared using the nonparametric Friedman test and Wilcoxon signed-rank test 131.[14] To compare categorical data, the Chi-square (χ^2) test was used. Instead, an exact test was utilized when the anticipated frequency was <5. Nonparametric McNemar and marginal homogeneity tests were performed to compare successive measures within each patient 132.[15] $P < 0.05$ were considered to indicate statistical significance.

RESULTS

The mean age was 52.12 ± 13.4 years (range 23–70 years), 22 (66.7%) were females, and 11 (33.3%) were males [Table 1].

Patients were divided according to the natural history of primary tumors into slowly growing tumors (breast, thyroid, prostate, and multiple myeloma) and rapidly growing tumors (bronchogenic carcinoma, transitional cell carcinoma, soft-tissue sarcoma, osteosarcoma, and adenocarcinoma) [Tables 1 and 2].

Twenty-two (66.6%) patients had lumbar spine involvement, 11 (33.3%) patients had dorsal spine involvement, and the extent of spine metastasis was oligometastasis (3 levels or less) in 18 (54.5%) patients, whereas multiple metastases (more than three levels) were observed in 15 (45.5%) patients. According to the ASIA scale, 1 (3%) patient was Grade A, 2 (6.1%) patients were Grade B, 7 (21.2%) patients were Grade C, 2 (6.1%) patients were Grade D, and 21 (63.6%) patients were Grade E disease [Table 3]. Patients were divided

Table 1: Patient demographics and data analysis

	Count (%)
Age	
<60	22 (66.7)
>60	11 (33.3)
Gender	
Male	11 (33.3)
Female	22 (66.7)
Complaint	
Neurology	10 (30.3)
Back pain	23 (69.7)
Primary tumor	
Slowly growing	25 (75.8)
Rapidly growing	8 (24.2)

Table 2: Demography of patients regarding the primary tumors of the spinal metastatic lesions

Primary tumor details	Count (%)
Transitional cell carcinoma	1 (3.0)
Thyroid cancer	4 (12.1)
Soft tissue sarcoma	3 (9.1)
Prostatic cancer	1 (3.0)
Osteosarcoma	1 (3.0)
Multiple myeloma	7 (21.2)
Bronchogenic carcinoma	2 (6.1)
Breast cancer	13 (39.4)
Adenocarcinoma colon	1 (3.0)

Table 3: The American Spinal Injury Association score and ambulatory status of patients pre- and postoperatively

	Pre, count (%)	Post, count (%)	*P*
Ambulatory status			
Walker	16 (48.5)	28 (84.8)	0.002
Nonwalker	17 (51.5)	5 (15.2)	
ASIA scale			
ASIA A, B	3 (9.1)	2 (6.1)	0.414
ASIA C, D	9 (27.3)	9 (27.3)	
E	21 (63.6)	22 (66.7)	

ASIA - American Spinal Injury Association into three groups according to the revised Katagiri score: 12 (36.4%) patients were at low risk (0–3), 18 (54.5%) patients were at intermediate risk (4–6), and 3 (9.1%) patients were at high risk (7–10).

Surgical data

En bloc resection was performed in 1 (3%) patient with metastatic osteosarcoma for curative management, whereas intralesional resection for decompression was performed in 20 (60.6%) patients. Posterior instrumentation was performed in all patients (100%) according to the SINS; 22 (66.6%) patients had potentially unstable spines,[7-12] while 11 (33.3%) patients had unstable spines. Anterior reconstruction was performed in 13 (39.3%) patients, with Pyramesh in 2 (6%) patients and with open transpedicular vertebroplasty in 11 (33.3%) patients, whereas posterior fixation was only performed in 20 (60.6%) patients [Figure 1]. The mean operative time was 2.79 h ± 0.96 standard hours (range: 2–6), and the mean hospital stay was 4.39 days ± 4.83 standard days (range: 2–30). Cement leakage into the canal occurred in 2 (6.1%) patients, one with percutaneous fixation and the other with open vertebroplasty and fixation, without neurological damage.

One patient had pathological collapse of D4, cord compression, and preoperative radiotherapy, undergone posterior fixation and decompression, complicated by heavy wound infection, and serial debridement without improvement, and another patient had dorsal myelopathy due to pathological fracture and cord compression at D9, complicated by complete neurological paraplegia postoperatively due to white cord syndrome.

The mean VAS score was 9.15 ± 0.87 SD preoperatively, improved to 3.42 ± 1.64 at 1 month postoperative, improved to 2.07 ± 2.26 at 6 months, and improved to 0.68 ± 1.42 at 12 months at the end of follow-up. There was a highly significant difference between the preoperative and postoperative VAS scores at the 1-, 6-, and 12-month follow-ups, with $P < 0.001$. The mean Euro-QOL score was − 0.84 ± 0.14 preoperatively, improved to 0.45 ± 0.48 at

Figure 1: 65 years old, metastatic breast cancer, mechanical back pain, and incomplete neurology, undergone posterior fixation and decompression and anterior reconstruction from posterior approach; (a) preoperative images, (b) immediate postoperative, (c) 6 months postoperative, (d) 12 months postoperative

1 month postoperative, improved to 0.61 ± 0.52 at 6 months postoperative, and improved to 0.83 ± 0.41 at 12 months postoperative. There was a highly significant difference between the pre- and postoperative QOL scores at the 1-, 6-, and 12-month follow-ups, with $P < 0.001$. The mean ODI was 84.39% ±9.19% preoperatively, improved to 49.76% ±20.99% at 1 month postoperatively, improved to 34.86% ±26.11% at 6 months postoperatively and improved to 15.11% ±19.66% at 12 months postoperatively. There was a highly significant difference between the preoperative and postoperative ODI scores at the 1-, 6-, and 12-month follow-ups, with $P < 0.001$. The mean ECOG score was 3.24 ± 0.75 preoperatively and improved to 1.73 ± 1.15 postoperatively. There was a highly significant difference between pre- and postoperative PS, with a $P < 0.001$ [Figure 2].

Regarding ambulatory status, 17 (51.5%) patients had preoperative walking problems (7 of them due to mechanical back pain and the rest due to neurological deficit), which decreased to 5 (15.2%) patients with postoperative walking problems. There was a highly significant change between the pre- and postoperative ambulatory status ($P = 0.002$). Four of those patients admitted were incontinent; two of them improved following surgery, whereas the others continued to have impaired urinary sphincteric function [Table 3].

The mean survival was 5.44 ± 3.46 months (range: 1–13), and there was no perioperative death (within 1 month postoperative). Sixteen patients (48.5%) survived for more than 1 year, and 17 (51.5%) patients died from different causes related to the natural history of tumor metastasis.

DISCUSSION

In our study, breast cancer, multiple myeloma, and thyroid cancer were significantly more common than other malignancies in patients with surgically treated spinal metastases and accounted for more than 70% of the included patients.

Westermann *et al*. reported that multiple myeloma, lung cancer, prostate cancer, and breast cancer accounted for 64.2% of all cancers.[16]

The lumbar spine was more frequently affected than the thoracic spine in our study, and the extent of spine metastasis was oligometastasis (3 or < 3 levels) in 18 (54.5%) patients, compared to 60% in Westermann *et al*.[16]

Dorsal spine metastasis has been reported by many studies to be the most common site of spine metastasis,[17] but Tatsui *et al*.[18] reported that 15% of the patients had cervical metastasis, 29.2% had dorsal metastasis, and 55.5% had lumbar metastasis.

The main indications for surgery were mechanical back pain due to unstable pathological fracture, radicular pain with failed conservative treatment, neurological deficits due to epidural spinal cord compression, and resection of solitary spine metastasis. Helweg-Larsen *et al*.[19] reported that the most common presentation was pain in 90% of the patients and neurological deficits in < 40% of the patients.

Regarding QOL, the Arabic version of the EQ-5D was used for the analysis of health-related QOL because, as stated by

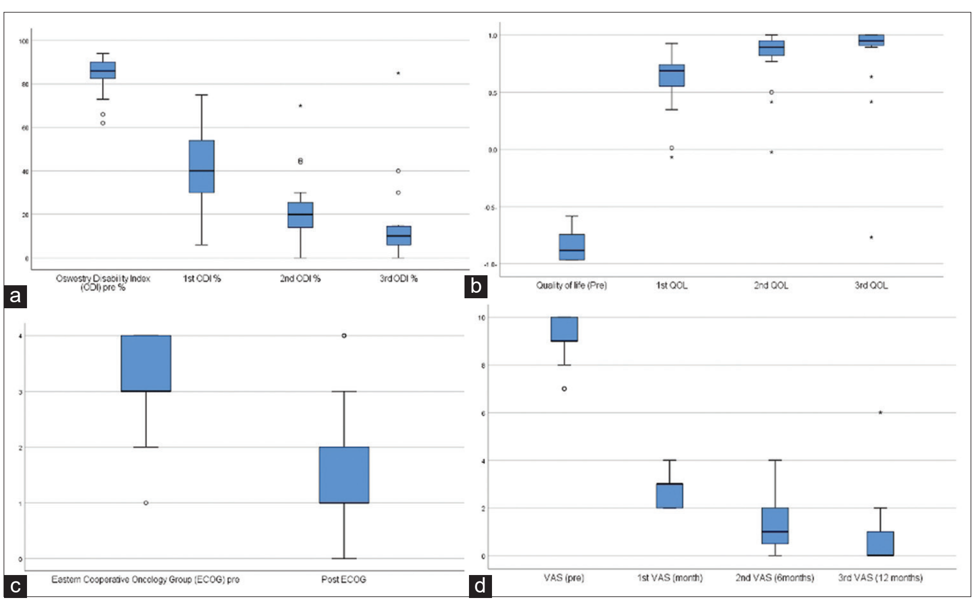

Figure 2: The preoperative, 1-month, 6-month, and 12-month postoperative scores of (a) Oswestry Disability Index, (b) EQ-5D, (c) Eastern Cooperative Oncology Group, (d) Visual Analog Scale. ODI: Oswestry Disability Index, QOL: Quality of life, ECOG: Eastern Cooperative Oncology Group, VAS: Visual Analog Scale

the Global Spine Tumor Study Group (GSTSG), it is a widely used validated, and applicable system. Although the EQ-5D is not specifically designed for assessing spinal metastases, it is important to assess the impact of surgery within the context of the whole patient, in whom spinal disease is only one of several factors that may affect QOL.[20]

Choi *et al*. concluded that survival and complication rates are the key parameters by which surgery for spinal metastases is measured, but very little data on patient-reported outcome measures for surgery for spinal metastases are available.[21]

In our study, the short-term QOL improved significantly, and the mean Euro-QOL score was − 0.84 preoperatively and improved to 0.45, 0.61, and 0.83 at 4 weeks, 6, and 12 months postoperatively, respectively, with $P < 0.001$, which is comparable to the results of Westermann *et al*.,[16] Quraishi *et al*.,[22] de Ruiter *et al*.,[23] and Quan *et al*.[24]

In our study, the mean VAS score improved significantly after surgery, and improvement was maintained at all follow-up examinations. The mean VAS score was 9.15 preoperatively and improved to 3.42 at 1 month postoperative, 2.07 at 6 months, and 0.68 at 12-month follow-up.

According to Westermann *et al*.,[16] improvement was accompanied by a significant improvement in pain control (assessed by the VAS) at all postoperative follow-up visits. Like the VAS score, the QoL improved significantly, with the maximum improvement observed at 12 months. This trend of long-term improvement with maximum improvement at the end of the study replicated the results of the study by Quan *et al.*[24] The same trend of further long-term improvement in QoL was also observed in the study by Choi *et al*.[21]

The postoperative ODI improved significantly; the mean ODI was 84.39% preoperatively, 49.76% at 1 month postoperatively, 34.86% at 6 months postoperatively, and 15.11% at 12 months postoperatively.

According to Westermann *et al*., the ODI improved at every follow-up assessment, which was analogous to the results of the study by Benard *et al*., in which the ODI improved from 70% to 25% at the end of the follow-up.[25]

In our study, PS assessed with the ECOG score improved over 12 months after surgery, and the mean ECOG score was 3.24 preoperatively, which improved to 1.73 postoperatively.

Regarding ambulatory status, 17 (51.5%) patients were nonwalkers preoperatively, which decreased to 5 (15.2%) patients postoperatively, and approximately 70% regained the ability to walk after surgery. There was a highly significant change between the pre- and postoperative ambulatory status, with $P = 0.002$.

Although the majority of similar studies were retrospective and did not evaluate patient-reported QOL,[15] several other surgical trials did reveal favorable results in terms of pain and ambulation.[25-27]

Regarding neurological deficits following surgery, 10 (30.3%) patients improved by one grade, 2 (6.1%) patients improved by two grades, and 2 (6.1%) patients worsened. Four patients were incontinent preoperatively, two of whom improved following surgery.

Regarding the type of intervention, posterior instrumentation was used in all patients (100%), anterior reconstruction was used in 13 (39.3%) patients, pyramidal instrumentation was used in 2 (6%) patients, and open transpedicular vertebroplasty was used in 11 (33.3%) patients. Posterior fixation was used in only 20 (60.6%) patients, and *en bloc* resection was used in one patient.

It is interesting to note that even for the comparatively more intrusive corpectomy operations, the QOL and functional result in our study were the same for all surgical techniques. This result was similar to that of de Ruiter *et al*., who found no difference in improvement between treatments including corpectomy and decompression plus stabilization.[23,28]

Although the aggregated results from several centers in the GSTSG study demonstrated that intraoperative complication rates are frequently unexpectedly high for less invasive surgical procedures, the anterior approach may be considered excessively aggressive for palliative surgery.[21]

The low reported frequency of tumor recurrence after the use of polymethyl methacrylate bone cement has led to suggestions that it has anticancer effects.[29] However, as Bròdano *et al*. pointed out, this effect might be related to these patients' poor prognosis.[30]

Furthermore, in the Dong *et al*. trial, the mean operating time for the vertebroplasty operation was lower than that of the corpectomy treatment, which also involved the implantation of a Pyramesh or expandable cage.[31]

The GSTSG concluded that life expectancy is usually determined by the overall extent of the metastatic disease, and therefore, to be of benefit, surgery must improve QOL. However, the incidence of complications increases with the complexity and extent of an operation, and therefore, at some point, there must be a trade-off between the benefits and risks of surgery.[32]

The complication rate in our study was 16%, which was lower than that in previous studies that reported rates of 20%–36% in patients with surgically treated spinal metastases.[16,20,26] Three patients experienced worsening of pain, QOL, and ODI.

Despite the significant early mortality risk following surgical therapy for spinal metastases, 5 (5.4%) patients pass away during the perioperative period, or the first 30 days following surgery.[33] In our analysis, there were no instances of perioperative mortality.

Sixteen (48.5%) patients survived at the 1-year follow-up, and 17 (51.5%) patients died due to different causes related to the natural history of the disease. The mean mortality time was 5.4 months (range 1–13 months).

In contrast to the previously reported rate of 40%–50% 9, 44.6% of patients in the Westermann *et al*. research died, whereas the overall 12-month survival was 55.6%. The recent general improvement in the prognosis of tumor patients may be one reason for this observation.[16] Including individuals with multiple myeloma, who have a better prognosis, could potentially be another factor.[34]

Subgroup analysis was not possible because of the heterogeneity of primary tumors and operations, despite the final patient count being limited. Similar to previous trials, there was a slight loss to follow-up at the conclusion of the research for various causes.[16] This is due to the fact that those who are affected typically have comorbidities, have higher emotional and psychological issues, and have a shorter lifetime.[35] Furthermore, we chose a subset of patients based on consensus among the surgeon, oncologist, and patient, potentially favoring those with better prognoses. An additional restriction was the absence of a control group.

Our data are a snapshot of the outcomes of spinal surgery and are not applicable to all individuals with metastatic spine tumors. Based on prognostic data from the oncology and surgical teams, such as life expectancy, patient expectations, and family discussions, the surgeon determines whether to do surgery. Patients who were carefully selected showed significant improvements in their functional, pain, and health-related QOL.

CONCLUSION

Surgical intervention can enhance QOL and function for patients with spinal metastases if appropriate patient selection, planning, and care are provided. Life expectancy, prognosis, neurological state, general and nutritional status, initial tumor type, spinal stability, and the existence of visceral metastases must all be taken into account while creating surgical plans.

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Conflicts of interest

There are no conflicts of interest.

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