











# Epidemiology of Spinal Metastases and Postsurgical Outcomes

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## Abstract

Spinal metastases are a common complication of systemic malignancies, significantly affecting patients' quality of life and survival. This observational and retrospective study aims to evaluate the epidemiological characteristics of patients undergoing surgery for spinal metastases at A.C. Camargo Cancer Center, as well as their functional status up to 60 days postsurgery. Medical records of patients treated between March 2022 and August 2024 were analyzed, including variables such as age, sex, tumor type, pre- and postsurgical functional status, metastasis location, and the type of intervention performed. The outcomes analyzed include postsurgical functional status, hospital discharge rates, hospitalization periods, and mortality rates. The analysis was conducted using the Stata 13 (StataCorp LLC.) software with appropriate statistical tests. The results provide an updated overview of the clinical profile and functional outcomes of operated patients, helping optimize the management of spinal metastases.

## Keywords

- ▶ metastasis
- ▶ spine
- ▶ neurosurgery

## Introduction

Spinal metastases, a relatively common and severe complication of systemic malignancies, significantly impact patients' quality of life and survival. Over the past decades, substantial progress has been made in understanding, diagnosing, and treating this condition. Chemotherapeutic medications for primary cancer control, radiotherapy, and advancements in surgical techniques remain the primary therapeutic modalities.

The prevalence of spinal metastases necessitates a robust diagnostic framework. Sciubba et al.<sup>1</sup> emphasize the

importance of early diagnosis through imaging modalities such as magnetic resonance imaging (MRI) and computed tomography (CT), which are crucial in assessing vertebral involvement and planning treatment strategies. These imaging techniques, combined with clinical evaluations, enable timely interventions, reducing the risk of irreversible neurological deficits.

Surgical intervention remains a cornerstone in managing spinal metastases, particularly in cases of spinal cord compression. A landmark randomized clinical trial by Patchell et al.<sup>2</sup> demonstrated that direct decompressive surgical resection combined with postoperative radiotherapy significantly improves ambulation and overall survival compared to radiotherapy alone. This study highlights the role of surgery in relieving spinal cord compression and improving patient outcomes.

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Bilsky et al.<sup>3</sup> further explore surgical techniques, focusing on the subaxial cervical spine. Their work underscores the challenges and considerations in managing metastatic and primary malignant tumors in this region, providing valuable insights into surgical decision-making and outcomes.

More recently, en bloc resection has been better understood. This technique involves the removal of the tumor in a single piece and, while technically demanding, it offers the potential for complete tumor removal, reducing local recurrence rates and improving long-term outcomes.<sup>4</sup>

Radiotherapy is a fundamental modality in managing spinal metastases, particularly for patients who are not surgical candidates. Rades and Abrahm<sup>5</sup> review the role of radiotherapy in treating metastatic epidural spinal cord compression, discussing various techniques and their outcomes. The authors emphasize the importance of tailoring radiotherapy protocols to patients' individual needs, balancing efficacy and toxicity.

Prognostic determination is crucial for treatment planning in spinal metastases. Rades et al.<sup>6</sup> developed a scoring system to predict overall survival in patients with metastatic spinal cord compression. This tool assists in making informed decisions regarding the aggressiveness of therapeutic interventions based on patient prognosis.

The Neurological, Oncological, Mechanical, and Systemic (NOMS)<sup>7</sup> framework integrates various clinical factors to guide treatment decisions. This comprehensive approach enables a personalized treatment strategy, optimizing outcomes by addressing the specific needs of each patient. Evidence-based guidelines for managing metastatic epidural spinal cord compression, grounded in clinical research, provide a structured approach to treatment, ensuring that patients receive the most appropriate and effective care.<sup>8</sup>

## Objective

The present study aims to evaluate the epidemiological characteristics of patients who underwent surgery for spinal metastases and their functional status up to 90 days postoperatively, to understand and implement the best neurosurgical treatment possible.

## Methodology

This observational and retrospective study was approved by the Ethics Committee of the State University of Londrina under approval number 7.382.258. Medical records of patients treated between March 1, 2022, and August 30, 2024, at the A.C. Camargo Cancer Center were analyzed. The study included patients who underwent surgery for spinal metastases, regardless of age, and examined their clinical status up to 90 days postsurgery. Patients with primary spinal tumors or incomplete medical records were excluded.

The independent variables analyzed were age, sex, histological type of the primary tumor, preoperative functional status evaluated by the Eastern Cooperative Oncology Group (ECOG) scale, American Spinal Injury Association (ASIA) scale for neurological deficits, metastasis location (cervical,

thoracic, or lumbar), and type of surgery performed (decompression, decompression with arthrodesis, arthrodesis). Outcome variables assessed based on medical records up to 90 days postoperatively included: ECOG, ASIA, neurological sequelae, neurological improvement, and mortality.

The data were analyzed using the Stata 13 (StataCorp LLC.) software, employing the Chi-squared tests for categorical variables and the Student's t-test for numerical variables.

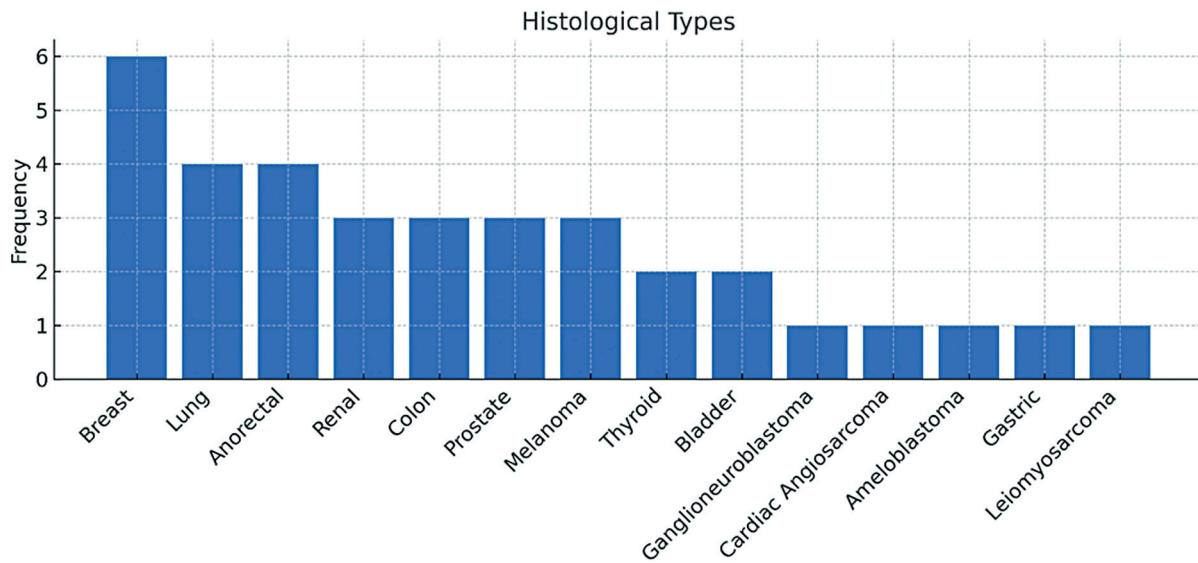
## Results

The final analysis, after applying exclusion criteria, included 35 patients (20 males and 15 females). The mean patient age was  $57 \pm 13$  years (► **Table 1**). The most common histological types of primary cancer were breast, followed by lung, anorectal, melanoma, and renal cancers (► **Fig. 1**).

Most patients (94.2%) underwent extensive spinal canal decompression followed by fixation via arthrodesis (anterior, posterior, or combined approach), as shown in ► **Table 1**. Patients who did not receive this treatment had a limited clinical condition that prevented them from undergoing such surgery or lacked a full indication for it. In these cases, only percutaneous arthrodesis or spinal decompression were performed. The most affected and consequently most

**Table 1** Demographic data and epidemiological outcomes of patients undergoing surgery for spinal metastases

Variable	N (%)
Age, years	$57 \pm 13$
Sex	
Male	20 (57)
Female	15 (43)
Histological type	
Breast	6 (17)
Lung	4 (11)
Anorectal	4 (11)
Melanoma	3 (8.5)
Renal	3 (8.5)
Colon	3 (8.5)
Surgical procedure	
Decompression	1 (2.86)
Percutaneous arthrodesis	1 (2.86)
Decompression and arthrodesis	33 (94.29)
Outcome	
Death	8 (22.86)
Sequelae	6 (17.14)
Neurological improvement	21 (60)
Cause of death	
Sepsis	6 (75)
Thromboembolism	1 (12.5)
Hemorrhagic shock	1 (12.5)



**Fig. 1** Primary histological types of spinal metastases analyzed.

**Table 2** Spinal level of surgery: absolute number and percentage

Operated level	N (%)
Cervical	6 (17.4)
Thoracic	18 (51.4)
Lumbar	7 (20.00)
Multiple levels	4 (11.43)

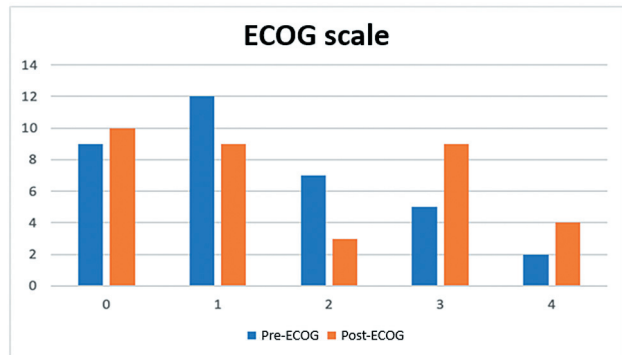
frequently operated spinal level was the thoracic region, followed by the lumbar, cervical, and multiple contiguous levels (►Table 2).

A mortality rate of 22% was observed among the patients evaluated at 90 days after surgery, with sepsis being the leading cause of death. Other immediate causes of death included pulmonary thromboembolism and hemorrhagic shock, though at lower proportions. Regarding outcomes, 60% of patients showed some degree of neurological improvement, while 17% maintained their preoperative neurological sequelae (►Table 1).

The 90-day postoperative mortality rate was of 22.86%, with sepsis as the leading cause of death (75%). Neurological improvement was observed in 60% of patients, whereas 17% maintained preoperative neurological deficits. Despite neurological recovery, ECOG scores (►Fig. 2) indicated clinical deterioration in some patients, likely due to the progression of systemic disease.

## Discussion

The data obtained from the analysis of 35 patients who underwent surgery for spinal metastases provide important insights into the neurosurgical management of this condition, as well as its outcomes. The mean patient age of 57 years, with a predominance of males (57%), is consistent with the literature, which indicates a higher prevalence of metastases



**Fig. 2** Pre- and postoperative ECOG classification: 0 - Fully preserved functionality; 1 - Symptoms of the disease present, but ambulatory and capable of self-care; 2 - Out of bed for more than 50% of the time; 3 - Confined to bed for more than 50% of the time and requires assistance with daily activities; 4 - Completely bedridden, requiring continuous assistance.

in middle-aged to elderly patients, reflecting the increased incidence of primary neoplasms in this age group.<sup>9</sup>

The primary histological types of metastases, notably breast (17%), lung (11%), and anorectal (11%) cancer, align with other studies that identify them as the most common sources of vertebral metastases.<sup>10</sup> This distribution highlights the need for early diagnosis and multidisciplinary strategies in managing oncologic patients with potential bone involvement.

The widespread use of decompression combined with arthrodesis (94.2%) reflects the standardization of a surgical approach aimed at restoring spinal stability and alleviating spinal cord compression.<sup>2-4</sup> This procedure was particularly common in the thoracic spine (51.4%), followed by the lumbar (20%) and cervical (17.4%) regions, which is expected given that the first is frequently affected by metastases due to its vascularization and anatomy.<sup>10</sup>

Despite the complexity of the procedure, the 90-day mortality rate was 22.86%, with sepsis being the leading

cause of death (75%). This underscores the importance of rigorous postoperative infection management, as well as careful screening to identify patients at higher risk for systemic complications.<sup>11</sup>

Neurological outcomes showed significant improvement in most cases, with 60% of patients progressing on the ASIA scale,<sup>12</sup> being reclassified to levels D and E. This finding demonstrates the positive impact of surgery in improving quality of life,<sup>13</sup> particularly for patients with severe preoperative neurological deficits. However, the increase in ECOG classification to levels 3 and 4 within 3 months postoperatively suggests that, although neurological function improved, overall clinical deterioration remains a challenge, possibly due to systemic disease progression.<sup>9</sup>

While the results are encouraging, the lack of statistical significance ( $p > 0.05$ ) in the evaluated parameters limits more robust conclusions. A small sample size and heterogeneity of the group may have contributed to this limitation. Future studies with larger cohorts and longer follow-ups are needed to validate these findings and explore additional prognostic factors, such as the impact of adjuvant therapies on surgical outcomes. Despite the limitations of this research, future studies with more robust approaches can complement our findings.

## Conclusion

Significant advances have been made in understanding and treating spinal metastases, driven by improved diagnostics and therapeutic strategies. Multidisciplinary approaches, early diagnosis, and ongoing research are critical to optimizing patient outcomes. Decompression and arthrodesis surgery remain the gold standard, for most cases, to enhance neurological prognosis. However, functional deterioration due to underlying disease progression remains a significant challenge.

### Authors' Contributions

All authors have contributed on conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, supervision, validation, visualization, writing – original draft, writing – review & editing.

### Conflict of Interests

The authors have no conflict of interests to declare.

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