Surgical Decompression and Stabilization for Spinal Metastases: A Systematic Review of Functional and Quality-of-Life Outcomes.

Giakoumettis D.[1,2], Argyros Ch.[1], Ampatsidou V.[1], Lilimpakis K.[1], Mourgela S.[1], Kyrgiannis K.[1], Bairaktaris A.[1], Petritsis K.[1]
1 Neurosurgery, General Anticancer and Oncological Hospital "Agios Savvas", Athens, Greece
2 Postdoctoral Researcher Democritus University of Thrace, Alexandroupoli, Greece

ABSTRACT

Introduction: Spinal metastases are common in patients with advanced cancer and often lead to debilitating pain, neurological deficits, and spinal instability.
Methods: A systematic review will be conducted following PRISMA guidelines in PubMed and Scopus databases without a time filter. An advanced search in Boolean logic was used and original studies in English, French, and German were included. These should report on the outcomes of surgical decompression and stabilization in adult patients with spinal metastases. Primary outcomes will include neurological improvement, pain reduction, and quality of life. Secondary outcomes will include overall survival and treatment-related complications. Case reports, reviews, systematic reviews, letters to the editor, grey literature, or annals from congresses will be excluded.
Objective: To evaluate the efficacy of surgical decompression and stabilization in improving neurological function, pain control, and quality of life in patients with spinal metastases, compared to non-surgical treatments such as radiotherapy alone.
Results: The initial search yielded a total of 62 studies (24 and 38 articles from Pubmed and Scopus, respectively). After screening titles and abstracts, 12 duplicates were removed, and 50 full-text studies were screened. Surgical decompression often results in significant neurological improvements in the American Spinal Injury Association (ASIA) and Frankel grades. A major benefit is also the reduction in pain levels, and additionally there is an improvement in the health-related quality of life (HRQOL), sustained up to one year post-surgery. Conversely, radiotherapy alone provides temporary improvement in pain scores, with no significant long-term changes in HRQOL.
Conclusions: Surgical decompression and stabilization, often followed by radiotherapy, offer significant functional and quality-of-life benefits for patients with spinal metastases. While surgery provides more substantial and sustained improvements compared to radiotherapy alone, it requires careful selection of patients and meticulous consideration of patient-specific factors and timely integration of therapies.
Keywords will include "spinal metastases," "surgical decompression," "stabilization," "radiotherapy," and "quality of life."

CONTACT

Dimitrios Giakoumettis
Neurosurgery, General Anticancer and Oncological Hospital "Agios Savvas", Athens, Greece
Email: dgiakoumettis@gmail.com

INTRODUCTION

- Spinal metastases are a frequent and debilitating complication of advanced cancer, affecting up to 70% of patients with metastatic disease.
- The thoracic spine is the most commonly involved region, followed by the lumbar and cervical segments. These lesions can cause severe pain, neurological deficits, and mechanical instability, significantly compromising patient mobility and quality of life (QOL).
- Radiotherapy has traditionally been the cornerstone of treatment for spinal metastases, but its efficacy in preserving neurological function or correcting mechanical instability is limited, particularly in cases of high-grade epidural spinal cord compression (ESCC) or spinal instability.
- Surgical decompression and stabilization have emerged as essential components of a multidisciplinary approach, especially for patients with neurological impairment or spinal instability. Advances in surgical techniques (i.e. minimally invasive surgery (MISS) and circumferential decompression) have improved safety and outcomes. Given the diversity of available interventions, treatment must be guided by frameworks such as NOMS (Neurological, Oncological, Mechanical, and Systemic considerations) and patient-centered goals.

METHODS AND MATERIALS

A **systematic review** was conducted in accordance with the **PRISMA 2020 guidelines**. An advanced search was done in a Boolean logic under the search terms ((((spinal metastases) AND (surgical decompression)) AND (stabilization)) AND (radiotherapy)) AND (quality of life), in two databases, **PubMed** and **Scopus.** A time filter was not applied.

Inclusion Criteria: We included
- Original studies **reporting on the outcomes of surgical decompression and stabilization** in adult patients with spinal metastases.
- **Primary outcomes** will include **neurological improvement, pain reduction, and quality of life.**
- **Secondary outcomes** will include **overall survival and treatment-related complications.**
- Studies in English, French and German.

Exclusion Criteria: We excluded
- Case reports/studies with < 10 patients, review articles (narrative review, systematic reviews, literature reviews), letters to the editor, grey literature, conference abstracts, non-human studies, and
- Any language other than abovementioned.

The screening process was initially done blindly based on title and abstract by two independent reviewers. Any discrepancies were resolved by a third one. Data extracted for our qualitative analysis included study characteristics, patient populations, treatment modalities, and reported outcomes.

RESULTS

Our search yielded initially a total of 62 articles (**PubMed:** 24 and **Scopus:** 38). Twelve (12) duplicates were removed, and 50 studies were included for full-text review. A total of 16 studies were included in our analysis comprising both retrospective and prospective cohorts. The pooled number of patients across studies included were 1609. Data extracted included for:

❖ Neurological Outcomes
- **Surgical decompression**, resulted in **improvements of neurological status**, measured by **ASIA or Frankel grades.**
- **Preservation or recovery of ambulation** was reported in the majority of patients, especially when **early intervention** was performed (Chart 1).

❖ Pain Relief and Spinal Stability
- **Visual Analogue Scale (VAS) scores showed marked reduction** post-surgery, from averages of 8–9 down to 2–3.
- **Stabilization** procedures, including percutaneous and MISS techniques, provided **durable mechanical support with low complication rates** (Chart 2).

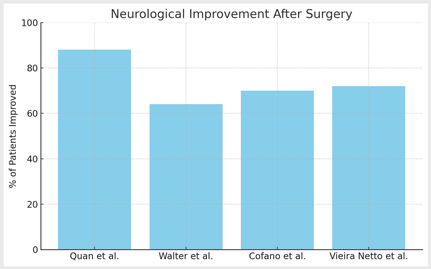

Chart 1. Neurological outcomes after surgery

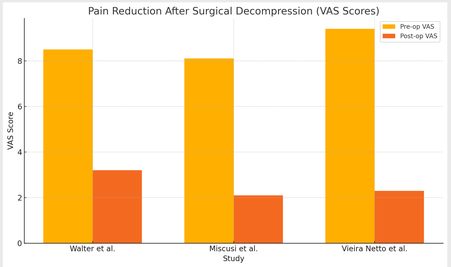

Chart 2. Pain relief after surgical decompression

RESULTS

❖ Quality of Life (QoL)
- Health-Related QOL (HRQOL) scores (i.e. SOSGOQ2.0, EORTC QLQ-C30, and SF-36) improved postoperatively and were **sustained up to 12 months.**

❖ Complications and Timing
- **Surgical complication rates ranged from 8-20%,** depending on technique and patient selection (Chart 3).
- **Delays (>35 days)** between surgery and adjuvant radiotherapy were linked to increased recurrence and neurological deterioration.

❖ Comparison between surgery and radiotherapy as a monotherapy
- **Radiotherapy alone** often achieved temporary pain relief but showed no significant impact on long-term neurological or QOL outcomes.
- **Surgery followed by radiotherapy** was associated with **greater functional gains and survival benefits** in selected patients (Chart 4).

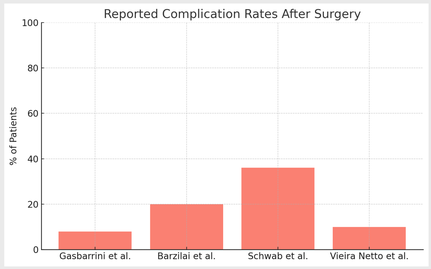

Chart 3. Complication rates after surgery

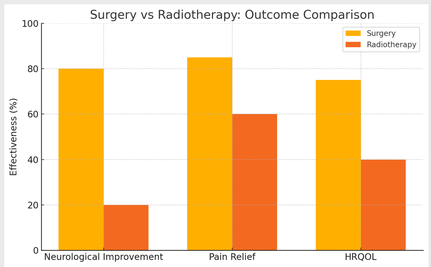

Chart 4. Outcome comparison between surgery and radiotherapy

DISCUSSION

Our study showed that **surgical decompression and stabilization** offer significant benefits in the management of spinal metastases, particularly in patients with **neurological deficits**, **mechanical instability**, and **intractable pain**.
Across the included studies surgery consistently led to improvements in **neurological function**, **pain control**, and **health-related quality of life (HRQOL)**.
Several studies showed that **anterior or other decompression** is more effective than posterior-only approaches, especially in cases of anterior or circumferential epidural compression. This supports the evolving paradigm of **separation surgery**, where strategic decompression is used to facilitate effective postoperative radiotherapy.
Pain reduction was consistently reported across studies, with Visual Analogue Scale (VAS) scores dropping from preoperative levels of 8–9 to postoperative values of 2–3. This improvement was often accompanied by **functional gains**, including restoration or maintenance of ambulation.
Quality of life improvements were noted in both physical and emotional domains, sustained up to one year postoperatively. These gains were particularly notable in patients with good preoperative performance status and lower systemic disease burden.
On the contrary, **radiotherapy alone**, while effective for short-term pain control, was not sufficient to preserve or restore neurological function in patients with significant cord compression. Furthermore, **delays in radiotherapy (>35 days post-op)** were associated with increased risk of **neurological deterioration and tumor recurrence**.
Despite these benefits, surgery carries **non-negligible risks**, with complication rates reported between **8% and 20%**. Careful **patient selection**, ideally guided by frameworks such as **NOMS**, **SINS**, and **ESCC** grading, remains critical.

CONCLUSIONS

Surgical decompression and stabilization provide substantial benefits in selected patients with spinal metastases, offering **neurological recovery**, **pain relief**, and **quality-of-life improvement**. Compared to radiotherapy alone, surgery enables more durable functional outcomes, particularly when followed by timely adjuvant radiotherapy. **Careful patient selection** and **multidisciplinary planning** are essential to optimize results and minimize risks.

REFERENCES

1. Knöll P, Lenschow M, Lenz M, et al. Local Recurrence and Development of Spinal Cord Syndrome during Follow-Up after Surgical Treatment of Metastatic Spine Disease. Cancers (Basel). 2023;15(19):4749. Published 2023 Sep 27. doi:10.3390/cancers15194749
2. Barzilai O, Sahgal A, Rhines LD, et al. Patient-Reported and Clinical Outcomes of Surgically Treated Patients With Symptomatic Spinal Metastases: Results From Epidemiology, Process, and Outcomes of Spine Oncology (EPOSO), a Prospective, Multi-Institutional and International Study. *Neurosurgery*. 2024;95(5):1148-1157. doi:10.1227/neu.0000000000002989
3. Cofano F, Di Perna G, Alberti A, et al. Neurological outcomes after surgery for spinal metastases in symptomatic patients: Does the type of decompression play a role? A comparison between different strategies in a 10-year experience. *J Bone Oncol*. 2020;26:100340. Published 2020 Nov 10. doi:10.1016/j.jbo.2020.100340
4. Walter J, Reichart R, Waschke A, Kalff R, Ewald C. Palliative considerations in the surgical treatment of spinal metastases: evaluation of posterolateral decompression combined with posterior instrumentation. *J Cancer Res Clin Oncol*. 2012;138(2):301-310. doi:10.1007/s00432-011-1100-3
5. Miscusi M, Polli FM, Forcato S, et al. Comparison of minimally invasive surgery with standard open surgery for vertebral thoracic metastases causing acute myelopathy in patients with short- or mid-term life expectancy: surgical technique and early clinical results. *J Neurosurg Spine*. 2015;22(5):518-525. doi:10.3171/2014.10.SPINE131201
6. Quan GM, Vital JM, Pointillart V. Outcomes of palliative surgery in metastatic disease of the cervical and cervicothoracic spine. *J Neurosurg Spine*. 2011;14(5):612-618. doi:10.3171/2011.1.SPINE10463
7. Faivre JC, Py JF, Vogin G, et al. Radiothérapie conformationnelle des métastases osseuses vertébrales [Conformal radiotherapy for vertebral bone metastasis]. *Cancer Radiother*. 2016;20(6-7):493-499. doi:10.1016/j.canrad.2016.07.081