THE LANCET
Oncology

# Supplementary appendix

This appendix formed part of the original submission and has been peer reviewed. We post it as supplied by the authors.

Supplement to: MacLean MA, Touchette CJ, Georgiopoulos M, et al. Systemic considerations for the surgical treatment of spinal metastatic disease: a scoping literature review. *Lancet Oncol* 2022; **23:** e321–33.

**Appendix Table of Contents:**

**Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist**

| SECTION | ITEM | PRISMA-ScR CHECKLIST ITEM | REPORTED ON PAGE # |
|---|---|---|---|
| **TITLE** | | | |
| Title | 1 | Identify the report as a scoping review. | Title Page |
| **ABSTRACT** | | | |
| Structured summary | 2 | Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives. | Page 2 |
| **INTRODUCTION** | | | |
| Rationale | 3 | Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach. | Page 3 |
| Objectives | 4 | Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives. | Page 3 |
| **METHODS** | | | |
| Protocol and registration | 5 | Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number. | Page 3 |
| Eligibility criteria | 6 | Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale. | Page 4 and Table 1 |

| SECTION | ITEM | PRISMA-ScR CHECKLIST ITEM | REPORTED ON PAGE # |
|---|---|---|---|
| Information sources* | 7 | Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed. | Page 4 |
| Search | 8 | Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated. | Page 4 and Supplemental Content B (expanded/full search strategy) |
| Selection of sources of evidence† | 9 | State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review. | Page 4 |
| Data charting process‡ | 10 | Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators. | Page 4 |
| Data items | 11 | List and define all variables for which data were sought and any assumptions and simplifications made. | Page 4 and Supplemental Content C (list of data extraction elements) |
| Critical appraisal of individual sources of evidence§ | 12 | If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate). | Page 5 |
| Synthesis of results | 13 | Describe the methods of handling and summarizing the data that were charted. | Page 4 and 5 |
| **RESULTS** | | | |
| Selection of sources of evidence | 14 | Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram. | Page 5 and Figure 1 |

| SECTION | ITEM | PRISMA-ScR CHECKLIST ITEM | REPORTED ON PAGE # |
|---|---|---|---|
| Characteristics of sources of evidence | 15 | For each source of evidence, present characteristics for which data were charted and provide the citations. | Page 5; Table 2 and 3 and 5; appendix pp 8-22 |
| Critical appraisal within sources of evidence | 16 | If done, present data on critical appraisal of included sources of evidence (see item 12). | Page 8 |
| Results of individual sources of evidence | 17 | For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives. | Pages 5-8; Tables 2 and 3-5; appendix pp 8-36 |
| Synthesis of results | 18 | Summarize and/or present the charting results as they relate to the review questions and objectives. | Pages 5-8; Tables 2 and 3-5; appendix pp 8-36 |
| **DISCUSSION** | | | |
| Summary of evidence | 19 | Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups. | Pages 8-10 |
| Limitations | 20 | Discuss the limitations of the scoping review process. | Page 10 |
| Conclusions | 21 | Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps. | Page 10 |
| **FUNDING** | | | |
| Funding | 22 | Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review. | Title Page and Page 11 |

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.
* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.
† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.
§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

*From:* Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.

**Search Strategy**

| Frailty | Spine | Surgery | Metastasis |
|---|---|---|---|
| (frail$ or "gait speed" or "sarcopenia" or "vulnerability elder survey" or "social vulnerability index" or KPS or "Karnofsky Performance Scale" or ecog or "Eastern Cooperative Oncology Group" or "ecog-ps" or "Eastern Cooperative Oncology Group performance score" or "patient fitness" or asa or "american society of anesthesiologists" or cga or "comprehensive geriatric assessment" or "c-sga" or "cancer specific geriatric assessment" or dss or "disease specific survival" or mFI or "modified frailty index" or "prognostic factor$" or "predictive factor$" or nesms or "new england spinal metastasis score" or nsqip or "national surgical quality improvement program" or PS or "performance status" or adl or "activities of daily living" or BI or "Barthel index" or frankel or nfs or "neurological function scale" or "preoperative nutrition" or "visceral adiposity" or albumin or hypoalbumin$ or "prealbumine" or "prealbumine" or "ASIA" or "American Spinal Injury Association" or "impairment scale" or "ais" or "muscle density" or morphometric$ or "ASD$" or "objective physical metric$" or "head and neck problem$" or "poor muscle tone" or "tilburg" or "freid phenotype" or "groningen index" or "physical fitness" or "weight loss" or "hand weakness" or "physical tiredness" or "grip strength" or "walking speed" or "osteoporosis" or "unsteady gait" or "excessive fatigue" or "poor balance" or "disabled" or "oswestry disability index" or | (spine$ or verteb$ or spinal$) | (surge$ or surgi$ or operati$ or postoperati$ or postsurg$ or presurg$ or preoperati$) | metasta$ |

| | | | |
|---|---|---|---|
| "ODI" or "charlson" or "srs arctivit$" or "srs-22" or "sf-36" or "BMD" or "bone mineral density" or "bmi" or "body mass index" "gastrointestinal disease$" or "thyroid disease$" or "abdominal disease$" or "myocardial infarction" or "arrhythmia" or "congestive heart failure" or "lung disease$" or "respiratory disease$" or "cerebrovascular disease$" or "diabetes mellitus" or "parkinson's disease$" or "Parkinson$" or "mood" or "depression" or "kidney disease$" or "neuromuscular disease$" or "liver disease$" or "peripheral vascular disease$" or "bladder incontinence" or "bowel incontinence" or "heart disease$" or "modifiable surgical variables" or "cardiac disease$" or "previous blood clot" or "smoking status" or "smoke" or "arthritis" or "bradykinesia" or "poor standing posture" or "falls" or "memory impairment" or "cognitive symptoms" or "delirium" or "cognitive impairment" or "tremor" or "degenerative disease$" or "syncope" or "snout reflex" or "palmomental reflex" or "irregular gait pattern" or "impaired vision" or "impaired hearing" or "difficulty with balance" or "retired" or "social life" or "level of activit$" or "alcohol abuse") | | | |

## Data Extraction Elements

1. Citation and Country of Publication
2. Study Design (Database)
3. Sample Size
4. Median or Mean Age (range, or SD if no range)
5. % male
6. Primary Cancer Site (% by Type)
7. Surgical Indication
8. Surgical Intervention
9. Statistical Analysis
10. Outcome Measure
11. Impact of Frailty Factor on Outcome
12. Median Post-op Survival (95% CI) and % Alive

**Full Data Extraction:** Study Characteristics

| Citation and Country of Publication | Study Design (Database) | Sample Size | Median or Mean Age in Years (range, or SD if no range) | % male | Primary Cancer Site (% by Type) | Surgical Indication | Surgical Intervention | Statistical Analysis Technique(s) |
|---|---|---|---|---|---|---|---|---|
| Cai et al. *World J Surg Onc* **2019** (China)[4] | Retrospective | 120 | 62 (27-88) | 59 | Lung (100%) | Neurologic deterioration due to SCC | Posterior decompression and internal fixation | Univariate and Multivariate Cox Regression models |
| Carl *et al J Neurosurg Spine* **2018** (USA)[18] | Retrospective | 159 | 59.6 (SD 11.7) | 54 | Bone marrow (multiple myeloma/plasmacytoma)<br>Lung<br>Breast<br>Kidney<br>Prostate<br>Colorectal<br>Uterus<br>Cervix<br>Skin | Oncological treatment/resection<br><br>Pre-op presentation:<br>Motor deficit (54%)<br>Sensory deficit (47%)<br>Pain (91%)<br>Gait dysfunction (40%)<br>Bladder dysfunction (7%)<br>Bowel dysfunction (4%) | "Resection of tumor"<br><br>Approach:<br>Anterior (28.5%)<br>Posterior (63.5%)<br>Combined (8.0%) | Log rank test<br><br>Univariate and multivariate Cox proportional hazards model (including factors with p-value <0.20 on univariate analysis) |
| Chen *et al. J Orthop Surg Res* **2015** (Taiwan/China)[29] | Retrospective | 50 | 61.6<br>(20-87) | 68 | Lung (100%) | Neurologic deterioration due to SCC | Anterior cervical (n=2)<br>Posterolateral transpedicular (n=45)<br>Combined Anterior corpectomy and posterior instrumentation (n=3) | Univariate and Multivariate Cox proportional hazards regression models |
| Cheung *et al. Global Spine J.* **2019** (USA)[40] | Retrospective<br><br>ACS NSQIP | 2202 | Not reported | 63 | Not reported | Neurologic deterioration due to SCC | Posterior decompression | Univariate analysis (chi-square) and multivariate logistic regression |
| Crnalic *et al. Acta Oncologica* **2013** (Sweden)[51] | Retrospective | 68 | 77 (60-88)<br><br>68 (45-86) | 100 | Prostate (100%) | Neurologic deterioration due to SCC | Posterior decompression +/- instrumentation | Univariate Fisher's Exact Test |
| De la Garza *et al. World Neurosurg* **2016** (USA)[62] | Retrospective<br><br>NISD | 4583 | 62 (54-70) | 59 | Lung (34.1%)<br>Breast (21.1%) Prostate (21.1%)<br>Kidney (19.9%) Thyroid (3.8%) | Oncological treatment/resection | Decompression (42.3%) +/- instrumentation (57.7%)<br><br>Anterior Approach (11.2%)<br>Posterior Approach (76.6%)<br>Combined Approach (12.2%) | Multiple logistic regression model |
| De la Garza *et al. World Neurosurg* **2020** (USA)[65] | Retrospective<br><br>ACS NSQIP | 1601 | 61.2 | 62 | Not reported<br><br>"Patients with disseminated cancer who underwent metastatic spinal tumor surgery" | Oncological treatment/resection | Excision Procedure (n = 39; 2.4%)<br><br>Fracture/dislocation reduction (n = 118; 7.4%)<br><br>Transpedicular or costovertebral for corpectomy (n = 82; 5.1%)<br><br>Lateral extracavitary for corpectomy (n 322; 20.1%) | Logistic Regression |

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|---|---|---|---|---|---|---|---|---|
| | | | | | | | Excision by laminectomy (n = 1025; 62.0%)<br><br>Instrumentation (n = 951; 59.4%) | |
| De la Garza *et al. Global Spine J* **2021** (USA)[66] | Retrospective<br><br>ACS NSQIP | 1226 | NHW:<br>62 (SD 12)<br><br>Black:<br>60 (SD 11) | NHW: 62<br><br>Black: 68 | Not reported<br><br>"Patients with disseminated cancer who underwent metastatic spinal tumor surgery" | Oncological treatment/resection | Excision Procedure (NHW:2.4%; Black 1.7%)<br><br>Fracture/dislocation reduction (NHW:7.8%; Black:5.2%)<br><br>Transpedicular or costovertebral for corpectomy (NHW: 5.4%; Black: 6.9%)<br><br>Lateral extracavitary for corpectomy (NHW: 20.0%; Black: 19.1%)<br><br>Excision by laminectomy (NHW: 64.6%; Black: 67.1%)<br><br>Instrumentation (NHW:61.7%; Black: 52.0%) | Univariate analysis (chi-square or Fishers Exact test) and multivariate logistic regression |
| Dea *et al J Neurosurg Spine* **2014** (Canada)[67] | Prospective | 101 | 62 (33-85) | 49 | Lymphoma<br>Breast<br>Non-small cell lung<br>Kidney<br>Colorectal<br>Prostate<br>Other | Neurological dysfunction due to SCC<br><br>Spinal instability | Posterolateral vertebrectomy<br><br>Decompression +/- instrumentation<br><br>Fusion only | Logistic Regression |
| Dea *et al Neurosurgery* **2020** (Canada)[8] | Retrospective | 253 | 57.5<br>(SD 11.2) | 49 | Breast (18.2%)<br>Lungs (19.8%)<br>Prostate (5.9%)<br>Kidney (15.8%)<br>Other (40.3%) | Neurological dysfunction due to SCC<br><br>Spinal Instability | Not reported | Univariate (t-test, chi-square, Wilcoxon rank-sum, or Fisher's eexact test) |
| Demura *et al. Spine* **2009** (Japan)[9] | Retrospective | 110 | 56 (32-72) | 59 | Lung (12.7%)<br>Breast (15.5%)<br>Prostate (4.5%)<br>Kidney (20.0%)<br>Thyroid (9.1%)<br>Liver (3.6%)<br>Colon (10.0%)<br>Other (24.5%) | Oncological treatment/resection | Wide or marginal excision *en bloc* spondylectomy (n=38)<br><br>Debulking (n=43)<br><br>Decompression + instrumentation (n=29) | Univariate and Multivariate logistic regression (factors included if $p<0.2$)<br><br>Fisher exact test |
| Dobran *et al J Neurosurg Sci* **2017** (Italy)[10] | Retrospective | 69 | 64 (22-87) | 57 | Breast (16%)<br>Prostate (14.5%)<br>Lung (16%)<br>Kidney (10%)<br>Colon (7%)<br>Unknown 1° (9%)<br>"Others" (27.5%) | Neurological dysfunction due to SCC<br><br>Spinal deformity<br><br>Intractable pain | Decompression (35%) +/- instrumentation (65%)<br><br>Approach:<br>Not reported | Univariate and Multivariate Cox proportional hazards model |

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|---|---|---|---|---|---|---|---|---|
| Ehresman *et al World Neurosurg* **2020** (USA)[11] | Retrospective | 95 | Nutrition Consult: 63<br><br>No Nutrition Consult: 60 | Nutrition Consult: 59<br><br>No Nutrition Consult: 60 | Nutrition Consult:<br>Breast: 17.7%<br>Lung: 29.4%<br>Prostate: 17.7%<br>Renal: 17.7%<br>Liver: 5.9%<br>Bladder: 5.9%<br>Pancreatic: 5.9%<br><br>No nutrition consult:<br>Breast: 25.6%<br>Lung: 24.4%<br>Prostate: 20.5%<br>Renal: 15.4%<br>Melanoma: 6.4%<br>Liver: 2.6%<br>Bladder: 1.3%<br>Thyroid: 2.6%<br>Colorectal: 1.3% | Oncological treatment/resection | Nutrition Consult:<br>Anterior: 5.9%<br>Posterior: 94.1%<br><br>No Nutrition Consult:<br>Anterior: 11.5%<br>Posterior: 80.8%<br>Combined: 7.7% | Univariable linear regression or one-way analysis of variance<br>Multivariate linear regression |
| Elsamadicy *et al Spine* **2020** (USA)[12] | Retrospective<br><br>HCUP NRD | 4423 | 30-day readmission: 60 (SD 15)<br><br>90-day readmission: 60 (SD 13)<br><br>No readmission: 62 (SD 14) | 30-day readmission: 61<br><br>90-day readmission: 60<br><br>No readmission: 61 | Not reported | Oncological treatment/resection<br><br>459<br>247<br>1272<br>1978 | 30-day readmission (n=1068):<br>Decompression only: 15%<br>Spinal fusion only: 57%<br>Decompression/fusion: 28%<br><br>90-day readmission (n=589):<br>Decompression only: 21%<br>Spinal fusion only: 58%<br>Decompression/fusion: 21%<br><br>No readmission (n=2766):<br>Decompression only: 20%<br>Spinal fusion only: 54%<br>Decompression/fusion: 26% | Multivariate logistic regression |
| Gakhar *et al Eur Spine J* **2015** (USA)[13] | Retrospective | 86 | Alive at 12m: 62 (53-71.5)<br><br>Deceased at 12m: 68 (61.8-76.3) | 51 | Lymphoma<br>Breast<br>Gastrointestinal<br>Prostate<br>Renal<br>Lung<br>Other | Neurological dysfunction due to SCC | Not reported | Mann Whitney Test<br>Fishers Exact test<br>Log Rank test |
| Gao *et al Global Spine J* **2021** (China)[14] | Retrospective | 55 | 79 (75-88) | 71 | Lung 25%<br>Prostate 18%<br>Thyroid 14.5%<br>Breast 13%<br>Kidney 9%<br>Colorectal 7%<br>Unknown 5%<br>Gastric 4%<br>Uterine 2% | Neurological dysfunction due to SCC | Decompression Alone: 80%<br><br>Total en-bloc spondylectomy: 20% | Chi square, t test<br><br>Multivariate logistic regression |

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|---|---|---|---|---|---|---|---|---|
| | | | | | Hepatic 2% | | | |
| Gao *et al Neurol Res* **2021** (China)[15] | Retrospective | 146 | Not reported | 59 | Lung (100%) | Neurological dysfunction due to SCC<br><br>Spinal instability<br><br>Intractable Pain | Decompression: 83%<br><br>Piece-meal spondylectomy: 13%<br><br>total en bloc spondylectomy: 4% | Univariate and multivariate Cox proportional hazard models |
| Gazzeri *et al J Neuro Onc* **2021** (Italy)[16] | Retrospective | 43 | 67 (39-91) | 47 | Lung (23%)<br>Breast (21%)<br>Prostate (16%)<br>Kidney (9%)<br>Melanoma (9%)<br>Ovarian (7%)<br>Unknown (5%)<br>Pancreas (2%)<br>Liver (2%)<br>Colon (2%) | Neurological dysfunction due to SCC<br><br>Intractable Pain | Posterior decompression: 96%<br><br>Posterior decompression + instrumentation: 4% | Chi-square or Fisher's exact test<br><br>Logistic and Cox Regression |
| Ha *et al. Clin Orthop Surg* **2015** (Korea)[17] | Retrospective | 43 | 58 (>6635-84) | 74 | Lung (58%)<br>Liver (42%) | Neurologic deterioration due to SCC<br><br>Pain due to instability | Posterior decompression + instrumentation (n=30)<br><br>Antero-posterior reconstruction (n=13) | Cox proportional regression model |
| Han *et al. Eur Spine J* **2015** (China)[19] | Retrospective | 30 | 52.2 (25-78) | 83 | Renal (100%) | Neurologic deterioration due to SCC | Posterior Decompression +/- instrumentation<br><br>Anterior approach for cervical cases | Univariate analysis via Log Rank test and Multivariate Cox proportional hazards analysis |
| He *et al. Oncotarget* **2017** (China)[20] | Retrospective | 155 | 50 (29-79) | 77 | Liver (100%) | Neurologic deterioration due to SCC | Anterior-posterior reconstruction | Multivariate Cox proportional hazards model |
| Hohenberger *et al J Clin Neurosci* **2018** (Germany)[21] | Retrospective | 94 | 64.1 (38-82) | 72 | Prostate<br>Breast<br>Kidney<br>Lung<br>Melanoma<br>Gastrointestinal<br>"Other"<br>CUO | Neurologic deterioration due to SCC | Decompression +/- vertebrectomy | Univariate and multivariate logistic regression |
| Hussain *et al Global Spine J* **2019** (USA)[22] | Retrospective<br><br>ACS NSQIP | 1498 | Normoalbuminemic: 41% ≥65 years of age<br><br>Hypoalbuminemic (<3.5g/dL): 36% ≥65 years of age | Normoalbuminemic: 65%<br><br>Hypoalbuminemic (<3.5g/dL): 64% | Not reported | Neurological deterioration due to SCC | Decompression only:<br><br>Normoalbuminemic: 48%<br>Hypoalbuminemic: 48%<br><br>Decompression + fusion:<br><br>Normoalbuminemic: 52%<br>Hypoalbuminemic: 52% | Chi-square and Fisher's exact test<br><br>Logistic regression |
| Jiang *et al. Int J Clin Exp Path* **2016** (China)[23] | Retrospective | 67 | 57 (32-76) | 54 | Lung (43%)<br>Breast (22%)<br>Liver (15%) | Neurologic deterioration due to SCC | Posterior decompression + Instrumentation, "with or without partial vertebrectomy" (n=67) | Log rank test |

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|---|---|---|---|---|---|---|---|---|
| | | | | | Renal (12%)<br>Prostate (8%) | | | Univariate and Multivariate Cox proportional hazards analysis |
| Kanda *et al Bone Joint J* **2020** (Japan)[3] | Retrospective | 101 | 65 (32-90) | 69 | Lung (19%)<br>Kidney (12%)<br>Breast (10%)<br>Liver 8%)<br>Thyroid (6%)<br>Lymphoma (6%)<br>Colon (6%)<br>Myeloma (6%)<br>Unknown (4%)<br>Others (24%) | Neurological dysfunction due to SCC<br><br>Spinal Instability<br><br>Intractable pain | Posterior decompression and instrumentation (100%) | Log-rank test<br><br>Multivariate logistic regression |
| Karhade *et al Br J Cancer* **2019** (USA)[24] | Retrospective | 732 | 61 (53-69) | 58 | Not reported | Oncological treatment/resection | Anterior: (14%)<br>Posterior: (90%)<br>Combined: (6%)<br><br>Decompression (96%)<br>Stabilization (87%)<br>Corpectomy (48%) | Cox proportional hazards model (overall survival)<br><br>Logistic regression (90d and 1 year mortality) |
| Kato *et al J Surg Oncol* **2016** (USA)[25] | Retrospective | 35 | 58.6 | 72 | Kidney (100%) | Neurological dysfunction due to SCC | Spondylectomy (n=35)<br><br>Corpectomy (n=1) | Log rank test |
| Lee *et al J Korean Neurosurg Soc* **2015** (Korea)[26] | Retrospective | 33 | 56 (28-71) | 91 | Hepatocellular (100%) | Neurological dysfunction due to SCC<br><br>Intractable pain | Decompression +/- instrumentation | Wilcoxon signed rank test<br><br>Log Rank Test |
| Lei *et al BMC Cancer* **2015** (China)[27] | Retrospective | 64 | 57 | 66 | Lung (100%) | Neurological dysfunction due to SCC | Decompression + instrumentation<br><br>Approach: not reported | Univariate analysis Log Rank test<br><br>Multivariate Cox proportional hazards model |
| Lei *et al Eur J Surg Oncol* **2015** (China)[28] | Retrospective | 95 | 57 (29-69) | 58 | Breast (21%)<br>Thyroid (16%)<br>Lung (42%)<br>Other (21%) | Neurological dysfunction due to SCC | Decompression + instrumentation<br><br>Approach:<br>Posterior (100%) | Ordered logit model<br><br>Log rank test<br><br>Univariate and multivariate Cox regression modelling |
| Li *et al J Orthop Surg Res* **2018** (China)[30] | Retrospective | 34 | 54 (34-72) | 50 | Lung (38%)<br>Breast (22%)<br>Gastrointestinal (6%)<br>Prostate (18%)<br>“Others” (17%) | Neurological dysfunction due to SCC<br><br>Spinal Instability<br><br>Intractable pain | Decompression + instrumentation (100%)<br><br>Approach:<br>Anterior (23.5%)<br>Posterior (64.7%)<br>Combined AP (11.8%) | MantelCox test<br><br>Wilcoxon signed-rank test<br><br>Pearson correlation analysis |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Longo *et al World Neurosurg* **2019** (USA)[31] | Retrospective | 58 | 60 (49-66) | 66 | Non-myelomatous (78%)<br><br>Myelomatous (22%) | Spinal Instability | Decompression (79%)<br>Corpectomy (20%)<br>Fusion (100%) | Fisher's exact test, Student t test, and Mann-Whitney U tests<br><br>Logistic regression |
| Massaad *et al J Neurosurg Spine* **2020** (USA)[32] | Retrospective | 86 | 64 (29-84) | 73 | Renal (100%) | Oncological treatment/resection | Not reported | Student t-test, Wilcoxon rank-sum, chi-square<br><br>Cox proportional hazard model |
| *Nater et al Cancer* **2018** (Canada)[33] | Prospective | 142 | 59 (47-71) | 58 | Lung (34%)<br>Kidney (22%)<br>Breast (21%)<br>Prostate (19%) | Neurologic deterioration due to SCC<br><br>Intractable pain<br><br>Spinal instability | Anterior decompression and reconstruction only (7%)<br><br>Posterior-only approach (58.5%)<br><br>Combined anterior and posterior approach (35%) | Cox proportional hazards model |
| Park *et al Neurospine* **2018** (Korea)[34] | Retrospective | 36 | 57.6 (38-73) | 83 | Lung (28%)<br>Kidney (6%)<br>Breast (6%)<br>GI (13%)<br>Hepatobiliary (38%)<br>Bladder(3%)<br>Prostate(6%) | Neurological dysfunction due to SCC<br><br>Intractable pain<br><br>Spinal instability | Corpectomy, reconstruction, instrumentation<br><br>Decompression + instrumentation<br><br>Approach:<br>Anterior (69%)<br>Posterior (28%)<br>Combined (3%) | Log Rank Test<br><br>Univariate and Multivariate Cox proportional hazards model |
| Park *et al J Korean Neurosurg Soc* **2011** (Korea)[35] | Retrospective | 103 | 54.6 (25-75) | 62 | Lymphoma<br>Multiple Myeloma<br>Breast<br>Colon<br>Hepatobiliary<br>Kidney<br>Liver<br>Lung<br>Prostate<br>Stomach<br>Thymus<br>Thyroid<br>Uterus<br>Bladder<br>CUO | Neurological dysfunction due to SCC | Posterior decompression + instrumentation<br><br>Combined anterior vertebrectomy + posterior decompression and instrumentation | Univariate and multivariate Cox regression modelling (Survival)<br><br>Univariate and multivariate logistic regression modelling (Post-op ambulation)<br><br>Log rank test (OS) |
| Park *et al. Spine J* **2016** (Korea)[36] | Prospective | 50 | 58.0 (26-79) | 54 | Lung (100%) | Neurologic deterioration due to SCC | Anterior Approach (Corpectomy + instrumentation) (n=5)<br>Posterior Approach (Decompression + instrumentation) (n=16)<br>Posterior Approach (corpectomy + instrumentation) (n=26)<br>Lateral Approach (corpectomy+ instrumentation) (n=3) | Paired t-test<br><br>Logistic regression analysis<br><br>Multivariate Cox proportional hazards model |

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|---|---|---|---|---|---|---|---|---|
| Park *et al. World Neurosurg* **2021** (USA)[37] | Retrospective | 44 | 65 | 68 | Renal (100%) | Neurological dysfunction due to SCC (32%)<br><br>Intractable pain (68%) | Decompression only (n=4; 10%)<br><br>Decompression + instrumentation (n=9; 20%)<br><br>Decompressio + instrumentation + Corpectomy (n=31; 70%) | Cox proportional hazards model |
| Pedreira et al *al J Clin Neurosci* **2017** (USA)[38] | Retrospective | 159 | Hardware failure: 65 (56-74)<br><br>No hardware failure: 60 (48-72) | With hardware failure: 53.9<br><br>No hardware failure: 33.3 | Hardware failure<br>Lung (22.4%)<br>Breast (18.6%)<br>Kidney (16.7%)<br>Bone marrow (14%)<br>Prostate (11%)<br>Colorectal (9)<br>Gynecological (5%)<br>Skin (5%)<br><br>No hardware failure<br>Lung (0%)<br>Breast (67%)<br>Kidney (0%)<br>Bone marrow (0%)<br>Prostate (33%)<br>Colorectal (0%)<br>Gynecological (0%)<br>Skin (0%) | Oncological treatment/resection | Not Reported | Cox proportional hazards model |
| Petteys *et al Neurosurg Focus* **2016** (USA)[39] | Retrospective | 30 | 57.6 (29-79) | 77 | Renal (100%) | Neurological dysfunction due to SCC (30%)<br><br>Severe back or extremity pain (70%) | Anterior approach, decompression + instrumentation (n=6)<br><br>Posterior decompression + instrumentation (n=15)<br><br>Anterior-posterior decompression + instrumentation (n=9) | Univariate analysis Log Rank test |
| Prost *et al J Neurosurg Spine* **2020** (USA)[41] | Prospective | 264 | 64 (SD19) | 56 | Lung (21%)<br>Breast (19%)<br>Kidney (13%)<br>Prostate (10%)<br>Colorectal (4%)<br>Head/Neck (3%)<br>Thyroid (3%)<br>Hepatic (3%)<br>Melanoma (2%)<br>Gynecologic (2%)<br>Bladder (2%)<br>Other (20%) | Oncological treatment/resection | Posterior decompression + instrumentation (n=154; 59%)<br><br>Posterior decompression only (n=22; 8%)<br><br>Posterior instrumentation only (n=9; 3%)<br><br>Posterior decompression + anterior column reconstruction (n=5; 2%)<br><br>Vertebrectomy + anterior and posterior instrumentation (n=13; 5%)<br><br>No data (n=61; 23%) | Logistic regression and cox proportional hazard models |

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| Putz *et al Oncology* **2014** (Germany)[42] | Retrospective | 43 | 63.7 (42-84) | 53 | Lung (40%)<br>Kidney (21%)<br>Breast (23%)<br>Prostate (16%) | Neurological deterioration due to SCC | Posterior decompression + instrumentation (n=24)<br><br>Posterior decompression (n=18)<br><br>Anterior-posterior decompression + instrumentation (n=1) | T-test (means)<br><br>Chi-square test (categorical variables)<br><br>Spearman rank-order correlation (continuous variables) |
| Schoenfeld *et al Spine* **2016** (USA)[43] | Retrospective | 318 | 60.2 (SD 13.2) | 58 | Lymphoma<br>Multiple Myeloma<br>Lung<br>Breast<br>Thyroid<br>Kidney<br>Prostate<br>"Other" | Oncological treatment/resection | Decompression (18%) +/- instrumentation (82%) | Bivariate and multivariate logistic regression (factors included if $p<0.2$) |
| Schuss *et al Neurosurg Rev* **2020** (Germany)[44] | Retrospective | 163 | With complications: 62 (SD 14)<br><br>Without complications: 65 (SD12) | Not reported | With complications:<br>Lung<br>Prostate<br>GI<br>Breast<br>Renal<br>Hematological<br>Muscle<br>Thyroid<br>Melanoma<br>Other | Neurological dysfunction due to SCC<br><br>Intractable Pain | Not reported | Multivariate logistic regression |
| Sebaaly *et al Spine* **2018** (Canada)[45] | Retrospective | 297 | 61 (SD 10.9) | 54 | Not reported<br><br>"Spinal metastasis of a known or unknown primary tumor" | Neurological dysfunction due to SCC<br><br>Spinal Instability | Posterior decompression + instrumentation (90.5%) +/- corpectomy (67%)<br><br>Anterior corpectomy + posterior instrumentation (9.5%) | T-test<br><br>Chi-square test<br><br>Multivariate analysis of variance<br><br>Multiple logistic regression |
| Sellin *et al J Neurosurg Spine* **2015** (USA)[46] | Retrospective | 43 | 51 (26-78) | 60 | Thyroid (100%) | Neurological deterioration due to SCC<br><br>Spinal deformity with intractable mechanical pain | Decompression + instrumentation<br><br>Approach:<br>Anterior (26%)<br>Posterior (65%)<br>Combined AP (9%) | Univariate and multivariate Cox proportional hazards regression |
| Shehadi *et al Eur Spine J* **2007** (USA)[47] | Retrospective | 87 | 53 (35-84) | 0 | Breast (100%) | Neurological dysfunction due to SCC<br><br>Intractable pain | Decompression (8%) +/- instrumentation (92%)<br><br>Approach:<br>Anterior (38%)<br>Posterior (35%)<br>Combined A-P (27%) | Logistic regression for post-op complications |

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| Tang *et al. J Bone Joint Surg Am* **2015** (China)[48] | Retrospective | 116 | 55.0 (26-79) | 65 | Lung (100%) | Neurologic deterioration due to SCC | Total en bloc spondylectomy with reconstruction (n=17)<br><br>Subtotal resection or total piecemeal spondylectomy +/- decompression with reconstruction (n=99)<br><br>Posterior approach for thoracic and lumbar cases (n=86)<br><br>Anterior or combined anterior and posterior for cervical cases (n=30) | Univariate analysis via Log Rank test<br><br>Multivariate Cox proportional hazards model (factors included if p<0.1) |
| Tatsui *et al J Neurosurg Spine* **2014** (USA)[49] | Retrospective | 267 | 59.2 (17-86) | 77 | Renal (100%) | Neurological dysfunction due to SCC | Decompression +/- reconstruction +/- instrumentation | Log Rank Test<br><br>Univariate and Multivariate Cox proportional hazards model |
| Truong *et al Clin Spine Surg* **2021** (Canada)[50] | Retrospective | 87 | 61 (SD1.9) | 55 | Lung (100%) | Neurological dysfunction due to SCC<br><br>Intractable pain<br><br>Spinal Instability<br><br>Oncological treatment/resection | Decompression, corpectomy, instrumentation (posterior): 86%)<br><br>Decompression, instrumentation (posterior): 13%<br><br>Decompression only: 1% | Log rank test<br><br>Cox hazards regression model |
| Vanek *et al Spine* **2015** (Czech Republic)[52] | Retrospective | 166 | 62.1 (SD 11.8) | Not reported | Hematologic Malignancy<br>Kidney<br>Lung<br>Prostate<br>Rectum<br>Thyroid<br>Thymoma<br>GI<br>Gynecologic<br>Carcinoid<br>Other | Neurological dysfunction due to SCC | Posterior decompression<br><br>"Anterior/posterior instrumented procedure"<br><br>"Combined instrumented procedure vertebrectomy" | Log Rank Test<br><br>Multivariate Cox regression modelling (variables with p<0.02 used to construct multivariate model; forward stepwise selection used with p<0.1) |
| Wang *et al J Pain Res* **2018** (China)[53] | Retrospective | 105 | 58 (56-61) | 51 | Lung (47.6%)<br>Breast (18.1%)<br><br>*No % reported:*<br>Prostate<br>Thyroid<br>Kidney<br>Uterus<br>Esophageal<br>Liver<br>Stomach<br>Colon | Neurological dysfunction due to SCC | Decompression + instrumentation | Multiple logistic regression models |

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|---|---|---|---|---|---|---|---|---|
| | | | | | Unknown primary | | | |
| Wang *et al World Neurosurg* **2019** (China)[54] | Retrospective | 72 | 56 (31-79) | 89 | Hepatic (100%) | Neurological dysfunction due to SCC<br><br>Oncological treatment/resection | Total en bloc spondylectomy, intralesional excision<br><br>Decompression + instrumentation | Log rank test<br><br>Cox proportional hazard model |
| Williams *et al J Neurosurg Spine* **2009** (USA)[55] | Retrospective | 44 | 66 (50-84) | 100 | Prostate (100%) | Neurological dysfunction due to SCC<br><br>Spinal deformity with intractable pain or medically intractable mechanical or neurological pain | Decompression (29%) +/- instrumentation (71%)<br><br>Approach:<br>Anterior (30%)<br>Posterior (40%)<br>Combined AP (30%) | Univariate and multivariate Cox proportional hazards model (factors included if $p < 0.15$) |
| Xu *et al Spine* **2018** (China)[56] | Retrospective | 49 | 58 (SD 10.4) | 59 | Lung (100%) | Neurological dysfunction due to SCC<br><br>Intractable pain | Total en bloc spondylectomy<br><br>Piecemeal spondylectomy | Log Rank Test<br><br>Univariate and Multivariate Cox proportional hazards model (factors included if $p<0.05$) |
| Yang *et al World Neurosurg* **2017** (Italy)[57] | Retrospective | 101 | 66 (SD 11.5) | 73 | Prostate (40%)<br>Lung (22%)<br>Breast (11%)<br>Others (19%)<br>Unknown (8%) | Neurological dysfunction due to SCC | Posterior decompression (100%) | Fisher's exact test and Student's t test |
| Younsi *et al Clin Exp Metastasis* **2020** (Germany)[58] | Retrospective | 53 | 59 (36-78) | 85 | Lung (100%) | Neurological dysfunction due to SCC | Decompression (47%) +/- instrumentation (53%) | Wilcoxon signed rank test<br><br>Log Rank Test |
| Zairi *et al Eur Spine J* **2016** (France)[59] | Retrospective | 271 | Smallest Psoas Tertile (n=90): 61 (SD13)<br><br>Middle Psoas Tertile (n=90): 61 (SD9.3)<br><br>Largest Psoas Tertile (n=91): 57.4 (SD12) | Smallest Psoas Tertile (n=90): 59<br><br>Middle Psoas Tertile (n=90): 58<br><br>Largest Psoas Tertile (n=91): 57 | Lung (23%)<br>Prostate (15%)<br>Renal (14%)<br>Breast (13%)<br>Hematological (8%)<br>GI (7%)<br>Nasopharynx (6%)<br>Thyroid (4%)<br>Hepatic (2%)<br>Skin (2%)<br>Other (7%) | Neurological dysfunction due to SCC<br><br>Spinal Instability | Instrumentation:<br><br>Smallest Psoas Tertile (n=90): 70%<br><br>Middle Psoas Tertile (n=90): 79%<br><br>Largest Psoas Tertile (n=91): 74% | Analysis of variance, Kruskal Wallace test, log rank test<br><br>Logistic regression and Cox proportional hazards models |
| Zakaria *et al Neurosurgery* **2020** (USA)[60] | Retrospective | 247 | 60 (25-87) | 52 | Multiple Myeloma<br>Lymphoma<br>Breast<br>Lung<br>Prostate<br>Gastrointestinal<br>Liver | Neurological dysfunction due to SCC<br><br>Intractable pain<br><br>Spinal Instability | Decompression +/- instrumentation +/- corpectomy<br><br>Approach:<br>Anterior<br>Posterior<br>Combined | Log Rank Test<br><br>Univariate and Multivariate Cox proportional hazards model (factors included if $p<0.05$) |

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|---|---|---|---|---|---|---|---|---|
| | | | | | Kidney<br>Thyroid<br>"Others" | | | |
| Zaw *et al Transfusion* **2017** (Singapore)[61] | Retrospective | 52 | 58 (26-82) | 32 | Thyroid (100%) | Neurological dysfunction due to SCC | Decompression + instrumentation (100%) | Univariate log rank test<br><br>Multivariate Cox regression analysis |
| Zhang *et al World Neurosurg* **2019** (China)[63] | Retrospective | 52 | 58 (26-82) | 32 | Thyroid (100%) | Neurological dysfunction due to SCC | Decompression + instrumentation (100%) | Univariate log rank test<br><br>Multivariate Cox regression analysis |
| Zhang *et al Front Oncol* **2021** (China)[64] | Retrospective | 411 | 58 (SD11) | 56 | Not reported | Neurological dysfunction due to SCC<br><br>Intractable pain<br><br>Spinal Instability | Decompression + instrumentation:<br><br>Subtotal corpectomy<br><br>en bloc spondylectomy | Univariate and multivariate logistic regression |
| *Abbreviations : American College of Surgeons National Surgical Quality Improvement Program Database (NSQIP), cancer of unknown origin (CUO), gastrointestinal (GI), Healthcare Cost and Utilization Project (HCUP), Nationwide Readmission Database (NRD), National Inpatient Sample Database (NISD), non hispanic white (NHW), overall survival (OS), progression free survival (PFS), spinal cord compression (SCC), standard deviation (SD). | | | | | | | | |

**Summary of Evidence**: Number of studies reporting statistically significant, negative associations between pre-operative systemic variables and post-operative survival outcomes, in univariate and multivariate analyses, respectively.

| Pre-operative Systemic Variable | OS (UV; MV) | 30d (UV; MV) | 90d (UV; MV) | <3m (UV; MV) | 12m (UV; MV) | 24m (UV; MV) | PFS (UV; MV) |
|---|---|---|---|---|---|---|---|
| **DEMOGRAPHICS** | | | | | | | |
| **Age** (Older) | 8[13,15,23,29,39,52,57,63]; 3[23,52,63] | -;- | 1[60]; - | -;- | 1[48]; - | 1[48]; - | -;- |
| **BMI** (Elevated; Obesity) | 1[33]; - | -;- | -;- | -;- | -;- | -;- | -;- |
| **BMI** (Low; Weight loss)[a] | 3[13,24,60]; 1[60] | 2[43,60]; 1[43] | 2[43,60]; 2[43,60] | -; - | -;- | -;- | -;- |
| **Gender** (Male) | 3[15,33,61]; 2[15,67] | -;- | -;- | 1[8];- | -;- | -;- | -;- |
| **Smoking** | 1[50]; 2[15,50] | -;- | -;- | -;- | -;- | -;- | -;- |
| **GENERALISED MOTOR WEAKNESS, AMBULATION** | | | | | | | |
| **Generalised Motor Weakness**[b] | 8[15,20,24,34,49,50,52,57,63]; 6[34,46,49,52,57,67] | -;- | -;- | 1[8];- | 2[32,48]; 2[32,48] | -; 1[48] | 1[20];- |
| **Ambulatory Status** | 3[27,28,39]; 1[28] | 1[43]; 1[43] | 1[43]; 1[43] | -;- | -;- | -;- | -;- |
| **PERFORMANCE STATUS OR PHYSICAL STATUS** | | | | | | | |
| **KPS <80; Dependent for ADLs** | 3[15,29,34]; 3[15,17,29] | 1[60]; - | 1[60]; - | -;- | 1[32]; 1[32] | -;- | -;- |
| **Worse ECOG-PS** | 8[14,20,23,24,27,28,57,61]; 6[20,23,24,27,57,61] | -;- | -;- | 1[8];- | 2[32,48];- | 1[48]; 1[48] | 1[20]; 1[20] |
| **Worse SF-36-PCS** | 1[33]; 1[33] | -;- | -;- | -;- | -;- | -;- | -;- |
| **MEDICAL COMORBIDITIES** | | | | | | | |
| **Higher CCI; "Any Comorbidity"** | 3[15,24,39]; 1[24] | -;- | -;- | -;- | -;- | -;- | -;- |
| **CHF; MI; CAD** | 1[60]; - | -;- | -;- | -;- | -;- | -;- | -;- |
| **Diabetes** | -;- | -;- | 1[60]; 1[60] | -;- | -;- | -;- | -;- |
| **Liver disease** | -;- | 1[60]; 1[60] | -;- | -;- | -;- | -;- | -;- |
| **Pathological Fracture(s)** | 1[15];- | -;- | -;- | -;- | -;- | -;- | -;- |
| **Pulmonary Disease** | 1[60]; 1[60] | -;- | -;- | -;- | -;- | -;- | -;- |
| **Stroke** | -;- | 1[60];- | -;- | -;- | -;- | -;- | -;- |
| **BIOCHEMICAL ABNORMALITIES** | | | | | | | |
| **Anemia; Low Hematocrit** | 1[24]; 1[24] | -;- | -;- | -;- | -;- | -;- | -;- |
| **Electrolyte Abnormalities** (Na, K, Mg, Phos, Ca) | -;- | -;- | -;- | -;- | -; 1[41] | -;- | -;- |
| **Elevated CRP** | -;- | -;- | -;- | -;- | -;1[41] | -;- | -;- |
| **Hypoalbuminemia; Malnutrition**[c] | 1[24]; 2[24,41] | 2[22,43]; 2[22,43] | 1[43]; 1[43] | -;- | 1[32]; 1[32] | -;- | -;- |
| **Elevated Serum Monocyte Count** | 1[15];- | -;- | -;- | -;- | -;- | -;- | -;- |
| **Elevated Serum Neutrophil Count** | 1[24];- | -;- | -;- | -;- | -;- | -;- | -;- |
| **Elevated Neutrophil:Lymphocyte Ratio** | 1[24];- | -;- | -;- | -;- | -;- | -;- | -;- |
| **Low Serum Lymphocyte Count** | 2[15,24]; 1[15] | -;- | -;- | -;- | -;- | -;- | -;- |
| **Elevated Platelet:Lymphocyte Ratio** | 1[24];- | -;- | -;- | -;- | -;- | -;- | -;- |
| **Elevated Serum Globulin** | 1[15]; 1[15] | -;- | -;- | -;- | -;- | -;- | -;- |
| **Elevated Serum ALP** | 2[15,24]; 1[24] | -;- | -;- | -;- | -;- | -;- | -;- |
| **Thrombocytopenia** | 1[24];- | -;- | -;- | -;- | -;- | -;- | -;- |

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|---|---|---|---|---|---|---|---|
| **Thrombocytosis** | 1[24];- | -;- | -;- | -;- | -;- | -;- | -;- |
| **SYSTEMIC DISEASE BURDEN** | | | | | | | |
| **Visceral Metastases** | 11[14,15,19,20,23,25,28,33,39,46,49]; 7[15,20,23,28,33,46,49] | -;- | -;- | -;- | -;- | -;- | 1[20]; 1[20] |
| **Abnormal Tumor Markers** | 1[4]; 1[4] | -;- | -;- | -;- | -;- | -;- | -;- |
| **HRQOL AND DISABILITY** | | | | | | | |
| **Worse HRQoL (EQ-5D)** | 1[33];- | -;- | -;- | 1[8];- | -;- | -;- | -;- |
| **Worse Disability (ODI)** | 1[33];- | -;- | -;- | -;- | -;- | -;- | -;- |
| **OTHER PROGNOSTIC MEASURES** | | | | | | | |
| **Tomita; Modified Tomita score** | 5[19,26,34,54,60]; 1[54] | -;- | 1[60];- | -;- | -;- | -;- | -;- |
| **Tokuhashi; Revised Tokuhashi score** | 7[19,35,37,50,52,54,60]; 6[19,35,50,52,54,60] | 1[60]; 1[60] | 1[60]; 1[60] | -;- | -;- | -;- | -;- |

[a] Includes: Low muscle mass and low psoas size
[b] Includes: Worse Frankel and Asia Impairment Scale grade
[c] Includes: Poor Nutritional Risk Index (<97.5)

**Abbreviations**: Activities of daily living (ADLs), Alkaline phosphatase (ALP), Body mass index (BMI); Calcium (Ca); Coronary artery disease (CAD); Charlson Comorbidity Index (CCI); Congestive heart failure (CHF); C-reactive protein (CRP); Day (d); Eastern Cooperative Oncology Group Performance Status (ECOG PS); EuroQoL-5D (EQ-5D); Health-related quality of life (HRQoL); Karnofsky Performance Score (KPS); Magnesium (Mg); Month (m); Multivariate analysis (MV); Myocardial infarction (MI); Oswestry Disability Index (ODI); Overall survival (OS); Potassium (K), Phosphorous (Phos); Progression Free Survival (PFS); Short-form 36 Physical Component Summary (SF 36-PCS); Sodium (Na), Univariate Analysis

**Summary of Evidence:** Number of studies reporting a statistically significant negative association between pre-operative systemic variables, complications, and other non-survival outcomes, in univariate and multivariate analyses, respectively.

| Pre-operative Systemic Variable | COMPLICATIONS UV/MV "Any" | Major | Minor | RBC Tx | SSI | Other | HRQoL (UV/MV) | LOS (UV/MV) | NHD (UV/MV) | PS (UV/MV) | Neuro-Function; Weakness (UV/MV) | Ambul-ation (UV/MV) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DEMOGRAPHICS** | | | | | | | | | | | | |
| **Age (Older)** | 1[53]; 3[53,55,67] | -;- | -;1[66] | -;- | | -;- | -;1[3] | -;- | -;- | -;- | -;- | -;- |
| **Age (Younger)** | 1[44]; - | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- |
| **BMI (Elevated; Obesity)** | -;- | -;- | -;- | 1[40];- (Fewer) | -;- | Pulmonary: 1[40]; - VTE: 1[40]; 1[40] UTI: -; 1[40] | -;- | 1[40]; - (Shorter) | -;- | -;- | -;- | -;- |
| **BMI (Low; Weight loss)[a]** | 1[60]; - | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -; 1[60] | -;- |
| **Gender (Male)** | 1[11]; - | -;- | -;- | 1[65]; - | -;- | -;- | -;- | -;- | -;- | 1[21]; 1[21] | -;- | 1[58]; - |
| **Race (Black)** | 1[66]; - | -;- | 1[66]; 1[66] | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | |
| **Smoking** | -; 1[66] | -;- | -;- | -;- | -; 1[45] | -;- | -;- | -;- | -;- | -;- | -;- | |
| **GENERALISED MOTOR WEAKNESS, AMBULATION** | | | | | | | | | | | | |
| **Generalised Motor Weakness[b]** | 1[44]; 1[44] | -;- | -;- | -;- | -;- | Pressure sores: -;1[67] VTE: 1[64]; 1[64] | -;- | -; 1[67] | 1[59]; - | -; 1[3] | -;- | 4[35,42,58,59]; 1[35] |
| **Ambulatory Status** | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | 1[28]; 1[28] | 4[35,36,42,58]; 1[35] |
| **PERFORMANCE STATUS OR PHYSICAL STATUS** | | | | | | | | | | | | |
| **Higher ASA-PS** | 2[11,44]; 1[44] | -;- | -;- | 1[65]; 1[65] | ; -;1[45] | -;- | -;- | 1[11]; - | -;- | -;- | -;- | -;- |
| **KPS <80; Dependent for ADLs** | 3[44,53,60]; 2[44,53] | -; 1[66] | -; 1[66] | -;- | -;- | Wound re-operation: 1[18]; - | -;- | -;- | 1[59]; - | -;- | -;- | 3[51,58,59]; - |
| **Worse ECOG-PS** | -;- | -;- | -;- | -;- | -;- | Hardware failure: 1[31]; 1[31] | -;- | -;- | -;- | -;- | 1[28]; - | -;- |
| **MEDICAL COMORBIDITIES** | | | | | | | | | | | | |
| **Bowel Dysfunction** | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | 1[58]; - |
| **Higher CCI; "Any Comorbidity"** | 3[11,14,53]; 2[11,53] | -;- | -;- | -;- | -;- | VTE: 1[64]; 1[64] | -;- | -;- | -;- | -;- | -;- | -;- |
| **CHF; MI; CAD** | 1[62]; 2[60,62] | -;- | -;- | -;- | -;- | -;- | -;- | 1[11]; 1[11] | -;- | -;- | -;- | -;- |
| **Diabetes** | 1[44]; 1[44] | -;- | -;- | -;- | 1[9]; 1[9] | -;- | -;- | -;- | -;- | -;- | -;- | -;- |
| **Inflammatory Conditions[c]** | -;- | -;- | -;- | -;- | -;- | Hospital readmission: -; 1[12] | -;- | -;- | -;- | -;- | -;- | -;- |
| **HTN** | -;- | -;- | -;- | -;- | -;- | Hospital readmission: -; 1[12] | -;- | -;- | -;- | -;- | -;- | -;- |
| **Pathological Fracture(s)** | 1[62]; 1[62] | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | |
| **Pulmonary Disease** | 1[62]; 1[62] | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | |

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| **Renal dysfunction; Renal Failure** | 1[62]; 2[60,62] | -;- | -;- | -;- | -;- | Hospital readmission: -; 1[12] | -;- | -;- | -;- | -;- | -;- | |
| **Stroke** | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -; 1[60] | -;- |
| **Urinary Dysfunction[d]** | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | 1[21]; 1[21] | -;- | 1[58];- |
| **BIOCHEMICAL ABNORMALITIES** | | | | | | | | | | | | |
| **Anemia; Low Hematocrit** | 1[62]; 1[62] | -;- | -;- | 1[65]; 1[65] | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- |
| **Coagulopathy** | 1[62]; 1[62] | -;- | -;- | 1[65]; - | -;- | Hospital readmission: -; 1[12] | -;- | -;- | -;- | -;- | -;- | -;- |
| **Electrolyte Abnormalities (**Na, K, Mg, Phos, Ca) | 2[24,62]; 1[62] | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- |
| **Elevated CRP** | 2[44,53]; 2[41,44] | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- |
| **Hypoalbuminemia; Malnutrition[e]** | 4[11,22,53,62]; 4[11,22,62,65] | -; 1[66] | -;- | 2[22,65]; 1[22] | -;- | Sepsis: 1[22]; 1[22] | -;- | 2[11,22]; 2[11,22] | 1[22]; 1[22] | -;- | -;- | -;- |
| **Elevated Serum Neutrophil Count** | 1[44]; - | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- |
| **SYSTEMIC DISEASE BURDEN** | | | | | | | | | | | | |
| **Visceral Metastases** | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | -;- | 1[28]; - | -;- |
| **OTHER PROGNOSTIC MEASURES** | | | | | | | | | | | | |
| **Mild Frailty (MSTFI)** | -;- | 1[62]; - | -;- | -;- | -;- | -;- | -;- | 1[62]; - | -;- | -;- | -;- | -;- |
| **Moderate Frailty (MSTFI)** | -;- | 1[62]; - | -;- | -;- | -;- | Inpatient mortality: 1[62]; - | -;- | 1[62]; - | -;- | -;- | -;- | -;- |
| **Severe Frailty (MSTFI)** | -;- | 1[62]; - | -;- | -;- | -;- | Inpatient mortality: 1[62]; - | -;- | 1[62]; - | -;- | -;- | -;- | -;- |
| **Katigiri Score** | -;- | -;- | -;- | -;- | -;- | -;- | -; 1[3] | -;- | -;- | -; 1[3] | -;- | -;- |
| **Tokuhashi, Revised Tokuhashi Score** | 1[60]; - | -;- | -;- | -;- | -;- | -;- | -;- | -;- | 1[59]; - | -;- | -;- | 2[35,58]; - |

[a] Includes: Low muscle mass and low psoas size
[b] Includes: Worse Frankel and Asia Impairment Scale grade
[c] Includes: Rheumatoid arthritis and other collagen vascular diseases
[d] Includes: Urinary retention and incontinence
[e] Includes: Poor Nutritional Risk Index (<97.5)

**Abbreviations**: Activity of daily living (ADL), Alkaline phosphatase (ALP), American Society of Anesthesiologists (ASA); Body mass index (BMI); Calcium (Ca); Coronary artery disease (CAD); Charlson Comorbidity Index (CCI); C-reactive protein (CRP); Eastern Cooperative Oncology Group Performance Status (ECOG PS); EuroQoL-5D (EQ-5D); Health-related quality of life (HRQoL); Hypertension (HTN); Karnofsky Performance Score (KPS); Magnesium (Mg); Multivariate analysis (MV); Myocardial infarction (MI); Neuro- (neurological); Non-home discharge (NHD); Oswestry Disability Index (ODI); Potassium (K); Phosphorous (Phos); Performance Status (PS); Short-form 36 Physical Component Summary (SF 36-PCS); Sodium (Na); Transfusion (Tx); Univariate Analysis; Urinary tract infection (UTI); venous thromboembolism (VTE)

**Full Data Extraction:** Systemic Variables Negatively Influencing Outcomes (Statistically Significant Results)

| **Citation and Country of Publication** | **Outcomes Negatively Impacted** | **Impact of Systemic Variable(s) on Outcome (Univariate Analyses)** | **Impact of Systemic Variable(s) on Outcome (Multivariate Analyses)** | **Median Post-op Survival (95% CI) and % Alive** |
|---|---|---|---|---|
| Cai et al. *World J Surg Onc* **2019** (China)[4] | Overall survival | HR (95%CI)<br>Abnormal tumor marker: 2.6 (1.6-4.0) (**p<0.001**) | HR (95%CI)<br>Abnormal tumor marker: 2.5 (1.6-3.9) (**p<0.001**) | Median OS: 6.8 (0.3-66) mo<br>@11.8mo: 8.3% alive |
| Carl *et al J Neurosurg Spine* **2018** (USA)[18] | Wound re-operation | OR (95%CI)<br>KPS≥70: 0.33 (0.1-0.9) (**P<0.025**) | No systemic variables were significant in analysis | Median OS (no wound re-operation: 13.3 (0.1-73) mo<br>Median OS (wound re-operation: 9.2 (1.1-41.8) mo |
| Chen *et al. J Orthop Surg Res* **2015** (Taiwan/China)[29] | Overall survival | HR (95%CI)<br>Age ≥75: 3.4 (1.4 -7.8) **(p = 0.008)**<br>KPS 80-100: 0.09 (0.03–0.3) **(p < 0.001)** | HR (95% CI))<br>KPS 80-100 : 0.14 (0.03–0.5) **(p = 0.004)** | Median OS: 7.5 (4.2-10.9) mo<br>@6mo: 58% alive |
| Cheung *et al. Global Spine J.* **2019** (USA)[40] | 30-day peri-operative outcomes | Pulmonary complications<br>Higher among obese patients (**p=0.05**)<br><br>VTE<br>Higher among obese patients (**p=0.014**)<br><br>Prolonged hospitalization<br>Lower among obese patients (**p=0.001**)<br><br>Blood transfusions<br>Lower among obese patients (**p<0.001**) | VTE; OR (95%CI)<br>Obesity: 1.75 (1.2-2.6) (**p=0.007**)<br><br>Urinary Tract Infection; OR (95%CI)<br>Obesity: 0.38 (0.2-0.95) (**p=0.038**) | Not applicable |
| Crnalic *et al. Acta Oncologica* **2013** (Sweden)[51] | 1 mo Post-operative Functional Status | KPS ≤ 70 vs. >70: **(p = 0.04)** | No systemic variables were significant in analysis | Not applicable |
| De la Garza *et al. World Neurosurg* **2016** (USA)[62] | "Development of at least one major peri-operative complication"<br><br>Application of the frailty index derived within manuscript to odds of inpatient | Association between systemic variables and ≥ 1 major complication<br>Anemia: More likely **(p<0.001)**<br>CHF: More likely **(p<0.001)**<br>Chronic lung disease: More likely **(p<0.001)**<br>Coagulopathy: More likely **(p<0.001)**<br>Electrolyte abnormalities: More likely **(p<0.001)**<br>Pulmonary circulation disorders: More likely **(p<0.001)**<br>Renal failure: More likely **(p<0.001)**<br>Malnutrition: More likely **(p<0.001)**<br>Pathologic fracture: More likely **(p<0.001)**<br><br>Association between Frailty (Mild, Moderate, Severe) and Inpatient mortality; OR (95% CI)<br>Moderate frailty: 5.15 (2.4-10.9) **(p<0.001)**<br>Severe frailty: 5.74 (2.7-12.2) **(p<0.001)**<br><br>Association between Frailty (Mild, Moderate, Severe) and Major Inpatient Complications; OR (95% CI) | Association between systemic variables and ≥ 1 major complication; OR (95%CI)<br>Anemia: 1.36 (1.1-1.7) **(p=0.001)**<br>CHF: 1.83 (1.2-2.7) **(p=0.009)**<br>Chronic lung disease: 1.64 (1.3-2.0) **(p<0.001)**<br>Coagulopathy: 1.98 (1.5-2.6) **(p<0.001)**<br>Electrolyte abnormalities: 2.66 (2.2-3.2) **(p<0.001)**<br>Pulmonary circulation disorder: 3.19 (2.3-4.4) **(p<0.001)**<br>Renal failure: 1.79 (1.2-2.7) **(p<0.001)**<br>Malnutrition: 2.11 (1.5-2.99) **(p<0.001)**<br>Pathological fracture: 1.23 (1.01-1.5) **(p=0.033)** | Not applicable |

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| | mortality and complication and LOS | Mild Frailty: 1.88 (1.33-2.66) **(p<0.001)**<br>Moderate Frailty: 3.83 (2.71-5.41) **(p<0.001)**<br>Severe Frailty: 6.97 (4.98-9.74) **(p<0.001)**<br><br><u>Association between Frailty (Mild, Moderate, Severe) and LOS; OR (95% CI)</u><br>Mild Frailty: 3.3 ± 0.4 days **(p<0.001)**<br>Moderate Frailty: 5.6 ± 0.4 days **(p<0.001)**<br>Severe Frailty: 6.4 ± 0.4 days **(p<0.001)** | | |
| De la Garza *et al. World Neurosurg* **2020** (USA)[65] | Red blood cell transfusion<br><br>30-day complications (any) | <u>Red Blood Cell Transfusion</u><br>Male Sex: **p=0.034**<br>Coagulopathy: **p=0.09**<br>Hypoalbuminemia: **p=0.008**<br>Prior transfusion: **p<0.001**<br>Preoperative anemia: **p<0.001**<br>Lower preoperative hematocrit: **p<0.001**<br>Higher preoperative international normalized ratio: **p=0.065**<br>Higher ASA class: **p=0.001** | <u>Red Blood Cell Transfusion; OR (95% CI)</u><br>Higher ASA class: 1.5 (1.2-2.1) **(p=0.003)**<br>Preoperative anemia: 3.1 (2.1-4.56) **(p<0.001)**<br><br><u>30-day Complications (any); OR (95% CI)</u><br>Red blood cell transfusion: 1.65 (1.1-2.6) (**p=0.022**)<br>Hypoalbuminemia: 1.53 (1.01-2.3) (**p=0.042**) | Not applicable |
| De la Garza *et al. Global Spine J* **2021** (USA)[66] | Overall complication rate<br><br>Clavien-Dindo Grade I-II (Minor) Complications<br><br>Clavien-Dindo Grade III-IV (Major) Complications | <u>Overall complications</u><br>Black race: Increased (**p=0.013**)<br><br><u>Grade I-II complications</u><br>Black race: Increased (**p=0.008**)<br><br><u>Grade III-IV complications</u><br>Not presented | <u>Overall complications</u><br>Not presented<br><br><u>Grade I-II complications; OR (95%CI)</u><br>Black race: 1.87 (1.2-3.01) (**p=0.008**)<br>Older Age: 1.02 (1.0-1.03) (**p=0.026**)<br>Dependent functional status (independent vs partially or fully dependent for ADLs): 1.84 (1.1-3.2) (**p=0.027**)<br><br><u>Multivariate; Grade III-IV complications; OR (95%CI)</u><br>Smoking: 2.56 (1.60-4.10) (**p<0.001**)<br>Dependent functional status (independent vs partially or fully dependent for ADLs): 2.93 (1.7-5.1) (**p<0.001**)<br>Hypoalbuminemia: 1.67 (1.1-2.6) (**p<0.001**) | Not applicable |
| Dea *et al J Neurosurg Spine* **2014** (Canada)[67] | Complications (any)<br><br>Pressure sores<br><br>Length of stay<br><br>Overall Survival | Univariate analysis not presented | <u>Complications (any)</u><br>Increased age: **p=0.035**<br><br><u>Pressure sores</u><br>Motor score: **p=0.031**<br><br><u>Increased LOS</u><br>Pre-op motor score: **p<0.0001**<br><br><u>Worse OS</u><br>Frankel score: Statistically significant (*no p value reported*)<br>Male Gender: Statistically significant (*no p value reported*) | Median OS: 8.4 mo |

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| Dea *et al Neurosurgery* **2020** (Canada)[8] | <3 month survival | Male gender: **p<0.001**<br>Worse ECOG score: **p=0.038**<br>Worse AIS score: **p<0.001**<br>Worse NRS score: **p=0.044**<br>Worse EQ-5D score: **p=0.001** | Multivariate analysis not presented | Median OS: Not reported<br><br>@3mo: 84.2% |
| Demura *et al. Spine* **2009** (Japan)[9] | Post-op SSI | <u>% with vs. % without SSI ; OR (95%CI)</u><br>Diabetes (Type 1): 17.7 (3.6-43.6) **p<0.01** | <u>OR (95%CI)</u><br>Diabetes: 17.1 (1.9-76.5) **p=0.011** | Not Reported |
| Dobran *et al J Neurosurg Sci* **2017** (Italy)[10] | Overall survival | No independent variables were significant in analysis | No independent variables were significant in analysis | Median OS: 7 mo (no range) |
| Ehresman *et al World Neurosurg* **2020** (USA)[11] | Post-op complications (30 days)<br><br>Hospital Length of Stay | <u>Increased 30-day complication rate</u><br>No pre-operative nutrition consult: (**p=0.028**)<br>Nutritional Risk Index <97.5 (moderate to severe malnourished): **p=0.0001**<br>Male (Gender): **p=0.012**<br>Hypoalbuminemia: **p=0.0001**<br>Modified CCI >1: **p=0.016**<br>Higher ASA Class: **p=0.004**<br><br><u>Increased hospital LOS</u><br>No pre-operative nutrition consult: Increased (**p=0.031**)<br>Nutritional Risk Index <97.5 (moderate to severe malnourished): **p=0.021**<br>Hypoalbuminemia: **p=0.012**<br>CHF: **p=0.004**<br>ASA Class: **p=0.009** | <u>Increased 30-day complication rate</u><br>Modified CCI >1: **p=0.007**<br>No pre-operative nutrition consult: **p=0.04**<br>Nutritional Risk Index <97.5 (moderate to severe malnourished): **p=0.01**<br><br><u>Increased hospital LOS</u><br>CHF: **p<0.0001**<br>Nutritional Risk Index <97.5 (moderate to severe malnourished): **p=0.004**<br>No pre-operative nutrition consult: **p=0.012** | Not applicable |
| Elsamadicy *et al Spine* **2020** (USA)[12] | 30 day readmission<br><br>31-90 day readmission | Univariate analysis not present | <u>30 day readmission; OR (95%CI)</u><br>Hypertension: 1.45 (1.2-1.8) (**p=0.002**)<br>Renal Failure: 1.53 (1.1-2.2) (**p=0.025**)<br><br><u>31-90 day readmission; OR (95%CI)</u><br>Rheumatoid arthritis or collagen vascular disease: 4.08 (1.5-11.5) (**p=0.008**)<br>Coagulopathy: 0.50 (0.3-0.97) (**p=0.04**) | Not applicable |
| Gakhar *et al Eur Spine J* **2015** (USA)[13] | 12-month Survival | <u>Worse 12-month survival</u><br>Increased age: **p=0.04**<br>Lower muscle mass: **p=0.02** | Multivariate analysis not presented | @12mo: 60.5% alive |
| Gao *et al Global Spine J* **2021** (China)[14] | Overall survival<br><br>Post-op complications (any) | <u>Worse overall survival</u><br>Pre-operative ECOG-PS 3-4 (vs 0-2) (**p=0.002**)<br>Presence of visceral metastasis (**P=0.03**)<br><br><u>Any complications</u><br>CCI > 0 (**p=0.04**) | <u>Worse overall survival; HR (95%CI)</u><br>Non-significant<br><br><u>Any complications; HR (95%CI)</u><br>Non-significant | Median OS: 18mo (13.5-22.5)<br><br>@12mo: 67.3% alive<br>@24mo: 36.4% alive |
| Gao *et al Neurol Res* **2021** (China)[15] | Overall survival | <u>HR (95%CI)</u><br>Male (Gender): 43.5 (7.8-250.0) (**p<0.001**)<br>Age >66 years: 11.0 (2.6-46.2) (**p=0.001**)<br>Any systemic comorbidity: 10.4 (1.9-55.6) (**p=0.007**)<br>Presence of bone metastases: 6.9 (2.0-24.4) (**p=0.003**)<br>Pathological fracture: 6.7 (1.9-23.3) (**p=0.003**)<br>Frankel Grade A-C (vs E): 111.1 (2.0-6172.8) (**p=0.02**) | <u>HR (95%CI)</u><br>Male (Gender): 3.9 (1.9-7.9) (**p<0.001**)<br>Smoking: 2.2 (1.2-4.2) (**p=0.01**)<br>Visceral metastases: 2.0 (1.0-3.9) (**p=0.04**)<br>KPS 50-70 (vs 80-100): 1.8 (1.02-3.09) (**p=0.04**)<br>KPS 10-40 (vs 80-100): 18.1 (5.8-56.4) (**p<0.001**)<br>Lymphocyte % ≤ 21.2 (vs >21.2): 1.9 (1.1-3.6) (**p=0.04**) | Median OS: 6mo<br><br>@12mo: 25%<br>@24 mo: 5% |

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| | | KPS 50-70 (vs 80-100): 12.8 (1.2-133.0) (**p=0.03**)<br>KPS 10-40 (vs 80-100): 17.9 (14.5-21.2) (**p<0.001**)<br>Monocytes % ≤ 6.5 (vs >6.5): 0.15 (0.04-0.6) (**p=0.009**)<br>Lymphocyte % ≤ 21.2 (vs >21.2): 6.2 (1.6-24.9) (**p=0.01**)<br>Serum globulin > 28.4 g/L (vs ≤ 28.4 g/L): 6.5 (2.4-18.3) (**p<0.001**)<br>Level of serum ALP ≤ 74 g/L (vs >74 g/L): 0.18 (0.05-0.69) (**p=0.01**) | Serum globulin > 28.4 g/L (vs ≤ 28.4 g/L): 3.61 (1.9-6.8) (**p<0.001**) | |
| Gazzeri *et al J Neuro Onc* **2021** (Italy)[16] | Overall survival<br><br>Neurological outcome (better vs unchanged or worse) | Overall survival; HR (95%CI)<br>Non-significant<br><br>Neurological outcome; HR (95%CI)<br>Non-significant | Overall survival; HR (95%CI)<br>Non-significant<br><br>Neurological outcome; HR (95%CI)<br>Non-significant | Median OS: 9.6 mo (3-26mo) |
| Ha *et al. Clin Orthop Surg* **2015** (Korea)[17] | Overall survival | Univariate analysis not presented | OR (95%CI)<br>Pre-op KPS: 0.93 (0.89-0.96) **(p<0.05)** | Mean OS (posterior surgery): 7.8 +/- 8.5y<br>Mean OS (anteroposterior): 10.4+/- 9.3y<br>@12mo: 31.5% alive (posterior only)<br>@12mo: 38.7% alive (anterior-posterior) |
| Han *et al. Eur Spine J* **2015** (China)[19] | Overall survival | Visceral metastases: (**p=0.03**)<br>Tomita score: (**p=0.03**)<br>Tokuhashi score: (**p=0.01**) | Tokuhashi score: 0.2 (0.06-0.8) (**p=0.02**) | Mean OS 17.0mo (12-32)<br><br>@12mo: 90% alive |
| He *et al. Oncotarget* **2017** (China)[20] | Progression Free Survival<br><br>Overall Survival | PFS<br>Frankel score preop E/C-D**:** (**p<0.001**)<br>ECOG 1-2 vs 3-4: (**p<0.001**)<br>Visceral metastases: (**p<0.001**)<br><br>OS<br>Frankel score preop E/C-D**:** (**p<0.001**)<br>ECOG 1-2 vs 3-4: (**p<0.001**)<br>Visceral metastases: (**p<0.001**) | PFS; HR (95%CI)<br>ECOG 1-2 vs 3-4: 1.8 (1.18-1.8) **(p=0.006)**<br>Visceral metastases: 1.7 (1.1-2.6) (**p=0.01**)<br><br>OS; HR (95%CI)<br>ECOG 1-2 vs 3-4: 1.7 (1.03-2.8) **(p=0.035)**<br>Visceral metastases: 2.7 (1.6-4.5) (**p=0.01**) | Median OS: 9.7 mo (1.0-59.0)<br>Median PFS: 7.0 mo (0.5-59.0)<br><br>@12m: 51.9% alive<br>@12m: 31.1% w/ PFS |
| Hohenberger *et al J Clin Neurosci* **2018** (Germany)[21] | "Poor outcome at discharge" (KPS<70) | OR (95%CI)<br>Gender (Male): 7.4 (2.3-24.0) (**p=0.001**)<br>Pre-op urinary retention: 11.5 (2.4-54) (**p=0.002**)<br>Pre-op loss of sphincter control: 20.1 (2.5-163) (**p=0.005**) | OR (95%CI)<br>Gender (Male): 7.8 (1.7-37.0) (**0.009**)<br>Urinary retention: 7.9 (1.5-43.3) (**p=0.017**)<br>Loss of sphincter control: 12.0 (1.4-107) (**0.026**) | Only short term data reported, with median follow up of 2 months |
| Hussain *et al Global Spine J* **2019** (USA)[22] | 30 d peri-operative mortality<br><br>Any complication<br><br>Sepsis<br><br>Transfusion (any) | Increased 30-d peri-op mortality<br>Hypoalbuminemia (**p<0.001**)<br><br>Increased complications (any)<br>Hypoalbuminemia (**p<0.001**)<br><br>Increased risk of sepsis<br>Hypoalbuminemia (**p<0.001**)<br><br>Increased rate of intra- or post-op transfusion<br>Hypoalbuminemia (**p<0.001**) | Increased 30-d peri-op mortality; OR (95%CI)<br>Hypoalbuminemia: 5.2 (3.4-8.0) (**p<0.001**)<br><br>Increased complications; OR (95%CI)<br>Hypoalbuminemia: 3.2 (2.4-4.1) (**p<0.001**)<br><br>Increased risk of sepsis; OR (95%CI)<br>Hypoalbuminemia: 3.1 (1.9-4.9) (**p<0.001**)<br><br>Increased rate of intra- or post-op transfusion; OR (95%CI)<br>Hypoalbuminemia: 1.4 (1.1-1.8) (**p<0.001**)<br><br>Prolonged length of stay > 10 days; OR (95%CI) | Not applicable |

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| | Length of stay<br><br><br><br>Non-home discharge | <u>Prolonged length of stay ≥ 10 days</u><br>Hypoalbuminemia (**p<0.001)**<br><br><br><u>Non-home discharge</u><br>Hypoalbuminemia (**p<0.001)** | Hypoalbuminemia: 4.3 (3.3-5.6) (**p<0.001)**<br><br><br><u>Non-home discharge; OR (95%CI)</u><br>Hypoalbuminemia: 2.9 (2.3-3.7) (**p<0.001)** | |
| Jiang *et al. Int J Clin Exp Path* **2016** (China)[23] | Overall survival | <u>Worse OS</u><br>Age >65: (**p<0.001**)<br>ECOG 3-4 (vs. 1-2): (**p<0.001**)<br>Visceral metastases: (**p<0.001**) | <u>RR (95% CI)</u><br>Age <65: 2.48 (1.2-5.1) (**p = 0.012**)<br>ECOG 1-2 (vs. 3-4): 1.84 (1.1-2.97) (**p=0.013**)<br>Visceral metastases: 2.6 (1.4-4.8) (**p=0.002**) | Median OS: 10.8 mo (7.3-14.3) |
| Kanda *et al Bone Joint J* **2020** (Japan)[3] | 6 mo post-op ECOG-PS (≥ 1 level change)<br><br>6 mo post-op Barthel Index (≥ 10 point change)<br><br>6 mo post-op EQ-5D (10% change) | Univariate analysis not presented | <u>Drop in ECOG-PS; OR (95%CI)</u><br>Katagiri score: 2.6 (1.4-4.8) (**p=0.002)**<br><br><u>Drop in Barthel Index; OR (95%CI)</u><br>Katagiri score: 1.9 (1.1-3.3) (**p=0.02**)<br>Frankel score: 0.18 (0.04-0.9) **(p=0.03**)<br><br><u>Drop in EQ-5D; OR (95%CI)</u><br>Age ≥ 70 years: 3.8 (1.1-13.4) (**p=0.04**)<br>Katagiri score: 1.9 (1.1-3.3) (**p=0.02**) | Median OS (patients <70 years of age):<br>10.2mo (5.2-15.1)<br><br>Median OS (patients ≥70 years of age):<br>11.2 mo (2.2-20.2) |
| Karhade *et al Br J Cancer* **2019** (USA)[24] | Overall survival | BMI <18 (vs 18-30): 1.8 (1.1-2.9) (**p=0.01**)<br>Higher CCI: 1.3 (1.1-1.5) (**p=0.007**)<br>ECOG 3-4: 2.7 (2.1-3.4) (**p<0.001**)<br>ASIA impaired (A-D): 1.5 (1.3-1.8) (**p<0.001**)<br>Anemia (Hemoglobin) <13 g/dL: 1.7 (1.4-2.0) (**p<0.001**)<br>Thrombocytopenia (<150x$10^3$/uL): 1.5 (1.1-1.9) (**p=0.004**)<br>Thrombocytosis (>450x$10^3$/uL): 1.4 (1.1-2.0) (**p=0.02**)<br>Absolute lymphocyte ($10^3$/uL) <1: 1.6 (1.3-1.9) (**p<0.001**)<br>Absolute neutrophil ($10^3$/uL) >6: 1.3 (1.1-1.6) (**p=0.01**)<br>Neutrophil to lymphocyte ratio ≥ 4.7: 1.8 (1.5-2.2) (**p<0.001**)<br>Platelet to lymphocyte ratio ≥ 408: 1.7 (1.4-2.0) (**p<0.001**)<br>Albumin <3.5 g/dL: 2.0 (1.6-2.4) (**p<0.001**)<br>Alkaline phosphatase (IU/L) ≥ 100: 1.8 (1.5-2.2) (**p<0.001)**<br>Calcium (mg/dL) ≥ 9: 0.7 (0.6-0.9) (**p<0.001**)<br>Creatinine (mg/dL) ≥ 1: 0.8 (0.6-0.9) (**p=0.009**) | <u>HR (95%CI)</u><br>Charlson Comorbidity other than metastases: 1.2 (1.02-1.4) (**p=0.03**)<br>ECOG 3-4: 2.7 (2.1-3.3) (**p<0.001**)<br>Anemia (Hemoglobin) <13 g/dL: 1.4 (1.1-1.7) (**p=0.001**)<br>Albumin <3.5 g/dL: 2.0 (1.7-2.5) (**p<0.001**)<br>Alkaline phosphatase (IU/L) ≥ 100: 1.3 (1.1-1.5) (**p=0.006)** | Median OS: Not reported<br>@12 mo: 45.7% alive |
| Kato *et al J Surg Oncol* **2016** (USA)[25] | Overall survival | Visceral metastases: (**P<0.001**) | No independent variables were significant in analysis | Median OS: 130 mo<br>@36mo: 77.8% alive<br>@60mo: 69.1% alive<br>@120mo: 58.0% alive |
| Lee *et al J Korean Neurosurg Soc* **2015** (Korea)[26] | Overall survival | Tomita score: (**p=0.02**) | No independent variables were significant in analysis | Median OS: 180 days (19-1351) |
| Lei *et al BMC Cancer* **2015** (China)[27] | Overall survival | <u>HR (95% CI)</u><br>Ambulatory: 2.24 (1.3-3.9) **(p=0.004)**<br>ECOG 1-2 (vs 3-4): 2.78 (1.5-5.0) **(p<0.001)** | <u>HR (95%CI)</u><br>ECOG: 2.18 (1.2-4.2) **(p=0.017)** | Median OS: 6.3 mo (4.5-7.4)<br>@6mo: 52.6% alive<br>@12mo: 23% alive |
| Lei *et al Eur J Surg Oncol* **2015** (China)[28] | Post-op motor function<br><br><br><br>Overall survival | <u>Univariate; Motor Function; OR(95%CI)</u><br>Pre-op ambulatory status: 3.81 (1.7-8.6) (**p<0.01**)<br>ECOG: 4.94 (2.1-11.7) (**p<0.01**)<br>Visceral metastases: 3.2 (1.4-7.3) (**p<0.01**) | <u>Motor Function; OR(95%CI)</u><br>Pre-op ambulatory status: 2.80 (1.17-6.7) (**p=0.02**) | Median OS: 10.9 mo (9.3-11.9)<br><br>@6mo: 76.6% alive<br>@12mo: 39.2% alive |

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| | | Univariate; OS; OR(95%CI)<br>Pre-op ambulatory status: 2.69 (1.7-4.3) (**p<0.01**)<br>ECOG: 2.85 (1.8-4.6) (**p<0.01**)<br>Visceral metastases: 2.2 (1.4-3.4) (**p<0.001**) | Multivariate; OS; OR(95%CI)<br>Pre-op ambulatory status: 1.91 (1.17-3.1) (**p=0.01**)<br>Visceral metastases: 2.1 (1.3-3.4) (**p<0.001**) | |
| Li *et al J Orthop Surg Res* **2018** (China)[30] | Overall survival | No independent variables were significant in analysis | No independent variables were significant in analysis | Median OS: 12.4 mo (3.5-36.2) |
| Longo *et al World Neurosurg* **2019** (USA)[31] | Hardware failure | ECOG-PS (**P=0.049**) | OR (95%CI)<br>ECOG-PS (3-4): 12.7 (1.1-156) (**p=0.047**) | Not applicable |
| Massaad *et al J Neurosurg Spine* **2020** (USA)[32] | 1 year survival | HR (95% CI)<br>KPS (moderate vs good): 6.8 (2.4-18.9) (**p=0.0002**)<br>KPS (poor vs good): 6.8 (2.0-23.5) (**p=0.003**)<br>ECOG (3-4 vs 1-2): 3.5 (1.6-7.9) (**p=0.002**)<br>Frankel grade (A-D vs E): 2.5 (1.01-6.5) (**p=0.049**)<br>Hypoalbuminemia (<3.5 g/dL): 4.1 (1.7-9.8) (**p=0.002**) | HR (95% CI)<br>KPS (moderate vs good): 5.3 (1.02-27.8) (**p=0.048**)<br>Frankel grade (A-D vs E): 5.1 (1.1-23.6) (**p=0.04**)<br>Hypoalbuminemia (<3.5 g/dL): 4.9 (1.2-19.4) (**p=0.02**) | @6mo: 79% alive<br>@12 mo: 72% alive |
| *Nater et al Cancer* **2018** (Canada)[33] | Overall survival | HR (95%CI)<br>Gender (Male): 1.59 (1.0-2.5) (**p=0.04**)<br>Elevated BMI: 0.945 (0.91-0.98) (**p=0.006**)<br>ODI: 10.014 (1.0-1.0) (**p=0.01**)<br>EQ-5D: 0.300 (0.1-0.7) (**p=0.005**)<br>SF-36 PCS: 0.95 (0.92-0.97) (**p<0.001**)<br>Metastasis to other organ(s) +/- extraspinal bone metastasis (yes vs no): 2.2 (1.4-3.4) (**p=0.0005**) | HR (95%CI)<br>SF-36 PCS: 0.95 (0.92-0.97) (**p<0.0001**)<br>Metastasis to other organ(s): 1.9 (1.3-3.2) (**p=0.005**) | Average 7.5 months (3-1085) |
| Park *et al Neurospine* **2018** (Korea)[34] | Overall survival | HR(95%CI)<br>Modified Tomita score: 2.9 (1.4-6.2) (**p=0.003**)<br>KPS <80 (vs. ≥80): 2.2 (1.0-4.96) (**p=0.04**)<br>Pre-op Sx, motor weakness (vs. pain): 3.3 (1.6-6.9) (**p=0.002**) | HR(95%CI)<br>Pre-op Sx, motor weakness (vs. pain): 4.0 (1.4-11.2) (**p=0.008**) | *Surgery before RT:*<br>Median OS: 15.3 mo (7.1-23.4)<br>@12mo: 41.7% alive<br>*RT before surgery:*<br>Median OS: 4.5 mo (3.4-5.5)<br>@12mo: 16.7% alive |
| Park *et al J Korean Neurosurg Soc* **2011** (Korea)[35] | Overall survival<br><br><br><br>Post-op ambulation | OS; HR(95%CI)<br>Tokuhashi score: 0.5 (0.2-0.8) (**p=0.005**)<br><br>Post-op Ambulation; OR (95%CI)<br>Pre-op ambulation w/ or w/out aid: 8.0 (2.5-26.0) (**p=0.001**)<br>Hip flexion power ≥3/5 : 6.2 (1.95-10.4) (**p=0.021**)<br>Tokuhashi score: 8.5 (1.1-66.3) (**p=0.04**) | OS; HR(95%CI)<br>Tokuhashi score: 0.5 (0.3-0.8) (**p=0.005**)<br><br>Post-op Ambulation; OR (95%CI)<br>Pre-op ambulation w/ or w/out aid: 5.4 (1.6-18.2) (**p=0.007**)<br>Hip flexion power >3/5: 6.2 (1.3-7.4) (**p=0.039**) | Median OS: 10.0 (8.21-11.80)<br>Median OS Ambulatory group: 11.0mo; (95%CI, 9.29-12.71)<br>Median OS Non-ambulatory group: 5.0mo; (95%CI, 1.80-8.20) |
| Park *et al. Spine J* **2016** (Korea)[36] | Post-op non-ambulatory status | Post-op ambulatory status; OR (95%CI)<br>Ambulatory (Pre-op): 17.7 (1.6-203.1) **(p=0.021)** | | Median OS: 5.2mo (95%CI: 2.36-5.84)<br><br>@6mo: 49.4% alive<br>@12mo: 22.4% alive |
| Park *et al. World Neurosurg* **2021** (USA)[37] | Overall survival | Tokuhashi score: (**p=0.03)** | Multivariate analysis not presented | Median OS: 8mo (0.3-92) |
| Pedreira et al *al J Clin Neurosci* **2017** (USA)[38] | Hardware failure | No independent variables were significant in analysis | No independent variables were significant in analysis | No hardware failure 16.7+/- 22.5mo<br>Hardware failure: 33+/-30mo |

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| Petteys *et al Neurosurg Focus* **2016** (USA)[39] | Overall survival | Older Age: Worse survival **(p=0.001)**<br>Non Ambulatory status: Worse survival **(p=0.001)**<br>Major comorbidites*: decreased survival **(p=0.02)**<br>*e.g. MI, CABG<br>Visceral metastases: worse survival (**p=0.002**) | Multivariate analysis not presented | Median OS: 11.4 mo (1mo – 9.9y) |
| Prost *et al J Neurosurg Spine* **2020** (USA)[41] | 12 month survival<br><br>Complications (any) | Univariate analyses not presented | <u>12 month survival</u><br>CRP > 10 mg/L: 2.7 (HR w/o CI reported) (**p<0.01)**<br>Albumin (>35 g/L): 0.5 (OR w/o CI reported) (**p<0.001**)<br>Hypercalcemia (>2.6 nmol/L): 2.3 (HR without CI reported) (**p<0.001**)<br><br><u>Complications (any)</u><br>CRP > 10 mg/L: 1.7 (HR without CI reported) (**p<0.01)** | @12mo: 33% alive |
| Putz *et al Oncology* **2014** (Germany)[42] | Change in ambulatory status<br><br>Change in Spinal Cord Injury Measure (sCIM) | <u>Ambulatory/Mobility Status</u><br>Pre-op mobility: (**p<0.001)**<br>Pre-op Frankel (AIS): (**p<0.001)**<br><br><u>Change in sCIM</u><br>Pre-op mobility: (**p<0.001)** | No independent variables were significant in analysis | Median OS: *Not reported* |
| Schoenfeld *et al Spine* **2016** (USA)[43] | Survival (30d)<br><br><br><br><br>Survival (90d) | <u>Survival 30d; OR(95%CI)</u><br>Ambulatory Pre-op: 9.6 (2.2-41.1) (*no p value reported*)<br>Albuminemia ≥3.5g/dl: 8.0 (3.0-21.7) (*no p value reported*)<br>BMI <18.5: 0.2 (0.1-0.7) (*no p value reported*)<br><br><u>Survival 90d; OR(95%CI)</u><br>Ambulatory Pre-op: 3.0 (1.7-5.4) (*no p value reported*)<br>Albuminemia ≥3.5g/dl: 3.5 (2.1-5.9) (*no p value reported*)<br>BMI <18.5: 0.6 (0.2-1.8) (*no p value reported*) | <u>Survival 30d; OR(95%CI)</u><br>Albuminemia ≥3.5d/dl: 9.0 (3.1-26.6) (**p<0.001**)<br>Ambulatory pre-op: 6.8 (1.5-30.7) (**p=0.01**)<br>BMI <18.5: 0.18 (0.04-0.8) (**p=0.02**) (*Decreased odds of survival*)<br><br><u>Survival 90d; OR(95%CI)</u><br>Albuminemia≥3.5d/dl: 3.9 (2.2-6.8) (**p<0.001**)<br>Ambulatory pre-op: 2.4 (1.3-4.5) (**p=0.006**) | @30d: 91% alive<br><br>@90d: 73% alive |
| Schuss *et al Neurosurg Rev* **2020** (Germany)[44] | 30-d post-operative complications | <u>Increased 30 day complications; OR (95%CI)</u><br>Younger age: No OR presented (**p<0.0001**)<br>WBC count >12 g/L: 2.9 (1.2-6.9) (**p=0.02)**<br>ASIA A (complete impairment): 3.6 (1.1-11.8) **(p=0.04)**<br>Diabetes: 4.3 (1.5-12.8) **(p=0.01)**<br>CRP>10 mg/mL: 4.4 (1.7-11.2) (**p=0.001**)<br>Low KPS: 5.1 (2.4-11.1) (**p<0.0001**)<br>ASA score 3 or 4: 16.3 (3.8-70.4) (**p<0.0001)** | <u>Increased risk of complications; OR (95%CI)</u><br>CRP>10 mg/mL: 4.4 (1.5-13.3) (**p=0.008**)<br>Low KPS: 2.8 (1.1-7.2) (**p=0.03**)<br>Diabetes: 6.4 (1.6-25.3) **(p=0.008)**<br>ASIA A (complete impairment): 4.5 (1.1-19.2) **(p=0.04)**<br>ASA score 3 or 4: 11.0 (2.3-52.8) (**p=0.003)** | Not applicable |
| Sebaaly *et al Spine* **2018** (Canada)[45] | Post-op SSI | Univariate analysis not presented | <u>SSI; OR (95% CI)</u><br>ASA ≥3: 1.1 (1.03-1.2) (**p = 0.02**)<br>Smoking: 2.4 (1.06-7.2) **(p=0.04)** | Mean OS: 196 days (SD 235 days) |
| Sellin *et al J Neurosurg Spine* **2015** (USA)[46] | Overall survival | <u>HR (95% CI)</u><br>Visceral metastases: 2.9 (1.4-5.8) **(p=0.004)**<br>Progressive Systemic Disease: 5.7 (2.7–12.1) (**p<0.001**) | <u>HR (95%CI)</u><br>Pre-op neurologic dysfunction: 3.0 (1.3-6.8) **(p = 0.008)**<br>Progressive systemic disease: 9.0 (3.5–23.3) (**p<0.001**) | Median OS: 15.4 mo (2.8-27.9) |
| Shehadi *et al Eur Spine J* **2007** (USA)[47] | Post-op complications | No independent variables were significant in analysis | No independent variables were significant in analysis | Median OS: 21 mo (16-27)<br>@12m: 62% alive<br>@36m: 33% alive |
| Tang *et al. J Bone Joint Surg Am* **2015** (China)[48] | 12 mo post-op survival<br><br><br>24m post-op survival | <u>12 mo survival</u><br>Age ≥ 60 (vs. <60): Shorter survival **(p<0.01)**<br>ECOG 1-2 (vs. 3-4): Longer survival (**p = 0.02**)<br>Frankel D (vs. A/B/C): Longer survival (**p = 0.02**) | <u>12 mo survival; HR (95%CI)</u><br>Frankel D (vs. A/B/C): 0.07 (0.02-0.4) (**p<0.01**) | Median OS: Not reported<br><br>@12mo: 58.5% alive<br>@24mo: 27.6% alive |

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| | Overall survival | 24 mo survival<br>Age ≥ 60 (vs. <60): Shorter survival **(p=0.04)**<br>ECOG 1-2 (vs. 3-4): Longer survival (**p = 0.04**)<br><br>OS<br>Non-significant | 24 mo survival; HR (95%CI)<br>ECOG 1-2 (vs. 3-4): 2.7 (1.2-6.2) (**p=0.02**)<br>Frankel D (vs. A/B/C): 0.2 (0.06-0.5) (**p<0.01**)<br><br>OS; HR (95%CI)<br>Non-significant | |
| Tatsui *et al J Neurosurg Spine* **2014** (USA)[49] | Overall survival | HR(95%CI)<br>Progressive systemic disease: 4.1 (3.1-5.4) (**p<0.001**)<br>Pre-op Frankel score A-D (vs. E): 2.3 (1.6-3.1) (**p<0.001**) | HR(95%CI)<br>Progressive systemic disease: 4.1 (2.9-5.8) (**p<0.001**)<br>Pre-op Frankel score A-D (vs. E): 1.8 (1.2-2.7) (**P<0.002**) | Median OS: 11.3 mo (9.5-13.0)<br>@12mo: 47% alive |
| Truong *et al Clin Spine Surg* **2021** (Canada)[50] | Overall survival | Smoking: (**p<0.01**)<br>Preoperative ASIA: (**p=0.02**)<br>Revised tokuhashi: **(p<0.01)** | HR (95%CI)<br>Smoking: 2.2 (1.2-3.8) (**p<0.01**)<br>Revised Tokuhasi Score (9-11 vs 0-8): 0.4 (0.2-0.8) (**p=0.01**) | Median OS: 4.1mo<br><br>@12mo: 16% alive |
| Vanek *et al Spine* **2015** (Czech Republic)[52] | Overall survival | HR (95%CI)<br>Older Age: (**p=0.007**)<br>Frankel grade (A-C vs D-E): (**P<0.001**)<br>Tokuhashi score: (**p<0.001**) | HR (95%CI)<br>Older age: 1.02 (1.00-1.04) (**p=0.017**)<br>Frankel grade (A-C vs D-E): 2.03 (1.3-3.2) (**p=0.002**)<br>Tokuhashi score: 1.6 (0.9-2.7) (**p<0.001**) | Median OS: 16.0mo (IQR: 4-48.4) |
| Wang *et al J Pain Res* **2018** (China)[53] | Post-op complications | OR (95%CI)<br>Older Age ≥60: 6.22 (2.3–16.7) (**p<0.01**)<br>KPS 10-40 (vs.50-100): 4.9 (2.3–10.5) (**p<0.01**)<br>CCI ≥9: 3.7 (1.5-9.3) (**p<0.01**)<br>Laboratory abnormality (CRP, LDH, albumin): 4.3 (1.7-11.3) (**p<0.01**) | OR (95%CI)<br>Older age ≥60: 3.5 (1.2–10.4) (**p=0.03**)<br>KPS: 4.24 (1.9–9.7) (**p<0.01**)<br>CCI ≥9: 3.17 (1.04–9.6) (**p=0.04**) | Median OS: 9.1 (7.1-11.4)<br>@6mo: 65.4% alive<br>@12mo: 36.8% alive |
| Wang *et al World Neurosurg* **2019** (China)[54] | Overall survival | Tomita score (5-7 vs 8-10): (**p<0.001**)<br>Tokuhashi score (0-8 vs 9-11): (**p<0.001**) | HR (95% CI)<br>Tomita score (5-7 vs 8-10): 2.3 (1.03-5.1) (**p=0.04**)<br>Tokuhashi score (0-8 vs 9-11): 0.4 (0.2-0.8) (**p<0.001**) | Mean OS: 10.8mo (SD 5.4) |
| Williams *et al J Neurosurg Spine* **2009** (USA)[55] | Overall survival<br><br>Complications (any) | Survival<br>No independent variables were significant in analysis | Survival<br>No independent variables were significant in analysis<br><br>Complications (any)<br>Age ≥ 65: (**p = 0.005)** | Median OS: 5.4 mo (0.8-10.1) |
| Xu *et al Spine* **2018** (China)[56] | Progression free survival<br><br>Overall survival | PFS; HR (95% CI)<br>Age <30: Longer in <30 yr group **(p=0.04)**<br><br>OS; HR (95% CI)<br>Age <30: Shorter in <30yr group **(p = 0.04)**<br>Pre-op Frankel score (A-C vs D-E): Shorter in A-C group **(p=0.02)** | PFS<br>No independent variables were significant in analysis<br><br>OS<br>No independent variables were significant in analysis | Median PFS: 40.5 mo (13-143)<br><br>Median OS: 42.6 mo (24-143) |
| Yang *et al World Neurosurg* **2017** (Italy)[57] | Overall survival | HR (95%CI)<br>Age (>60): Shorter survival (**p<0.001**)<br>ECOG 2-3 (vs 1): Shorter survival **(p<0.01**)<br>ECOG 4 (vs 1): Shorter survival<br>ASIA D-E (vs A-C): Longer survival | HR (95%CI)<br>ECOG 3-4 (vs 1-2): 0.1 (0.01-0.2) **(p<0.01**)<br>ASIA D-E vs (A-C): 0.1 (0.02-0.8) **(p=0.03**) | Median OS: 13 mo (no range) |
| Younsi *et al Clin Exp Metastasis* **2020** (Germany)[58] | Post-op Ambulation | Ambulatory post-op<br>Male Gender: (**p<0.001**)<br>KPS >50: (**p<0.0001**)<br>Frankel D-E (vs A-C): (**p<0.0001**)<br>Absence of bladder dysfunction: (**p=0.04**)<br>Absence of bowel dysfunction: (**p<0.0001**) | Multivariate analysis not presented | Not reported |

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| | | Grade of paresis >3/5 (vs <4/5): (**P<0.0001**)<br>Ambulatory on admission: (**p<0.0001**)<br>Lower Tokuhashi score: (**p=0.04**) | | |
| | Regaining Ambulatory Post-op | <u>Regaining Ambulation Post-op; RR (95%CI)</u><br>Bowel disorder: 0.3 (0.1-0.6) (**p=0.002**)<br>KPS >50: 4.4 (1.2-17.4) (**p=0.04**)<br>Frankel A: 0.3 (0.1-0.8) (**p=0.01**)<br>Frankel C: 1.8 (1.3-2.6) (**p=0.001**) | | |
| Zairi *et al Eur Spine J* **2016** (France)[59] | Ambulation | <u>Ambulation</u><br>KPS: (**p<0.001**)<br>Frankel Score: (**p=0.02**) | Multivariate analysis not presented | Median OS: 2.1 mo (no range) |
| | Post-op discharge hospital to home | <u>Non-Discharge Home</u><br>KPS <80: (**p = 0.02**)<br>Frankel grade: (**p=0.009**)<br>Tokuhashi score: (**p=0.04**) | | |
| Zakaria *et al Neurosurgery* **2020** (USA)[60] | 30d mortality | <u>30d mortality; OR (95%CI)</u><br>Stroke: 4.8 (1.4-16.4) (p=**0.01**)<br>Liver disease: 5.8 (1.6-20.3) (**p=0.006**)<br>Middle tertile psoas size (vs smallest tertile): 0.6 (0.4-0.8) (**p<0.001**)<br>Largest tertile psoas size (vs smallest tertile):0.4 (0.3-0.6) (**p<0.001**)<br>Tokuhashi score: 0.8 (0.6-0.9) (**p=0.001**)<br>KPS: 0.96 (0.94-0.99) (**p=0.001**) | <u>30d mortality; OR (95%CI)</u><br>Liver disease: 7.6 (1.2-47.0) (**p=0.03**)<br>Tokuhashi score: 0.7 (0.5-0.98) (**p=0.001**) | 90 day mortality (%):<br><br>Smallest Psoas Tertile: (n=40; 44%)<br><br>Middle Psoas Tertile: (n=19; 21%)<br><br>Largest Psoas Tertile: (n=12; 13%) |
| | 90d mortality | <u>90d survival; OR (95%CI)</u><br>Age (older): 1.3 (1.1-1.7) (p=**0.01**)<br>Diabetes: 2.7 (1.4-5.1) (**p=0.003**)<br>Middle tertile psoas size (vs smallest tertile): 0.3 (0.2-0.6) (**p=0.001**)<br>Largest tertile psoas size (vs smallest tertile): 0.2 (0.1-0.4) (**p<0.001**)<br>Tokuhashi score: 0.7 (0.7-0.8) (**p<0.001**)<br>Tomita score: 1.3 (1.1-1.4) (**p<0.001**)<br>KPS: 0.97 (0.96-0.99) (**p<0.001**) | <u>90d survival; OR (95%CI)</u><br>Diabetes: 2.8 (1.01-7.8) (**p=0.046**)<br>Middle tertile psoas size (vs smallest tertile): 0.2 (0.09-0.6) (**p=0.003**)<br>Largest tertile psoas size (vs smallest tertile): 0.16 (0.05-0.4) (**p<0.001**)<br>Tokuhashi score: 0.7 (0.6-0.9) (**p=0.002**) | |
| | Overall survival | <u>OS; OR (95%CI)</u><br>MI/CAD: 1.7 (1.2-2.5) (**p=0.004**)<br>COPD: 1.7 (1.2-2.5) (**p=0.005**)<br>Low BMI: 0.97 (0.94-0.99) (**p=0.012**)<br>Middle tertile psoas size (vs smallest tertile): 0.6 (0.4-0.8) (**p<0.001**)<br>Largest tertile psoas size (vs smallest tertile): 0.4 (0.3-0.6) (**p<0.001**)<br>Tokuhashi score: 0.9 (0.86-0.93) (**p<0.001**)<br>Tomita score: 1.2 (1.1-1.2) (**p<0.001**) | <u>OS; OR (95%CI)</u><br>COPD: 1.7 (1.1-2.7) (**p=0.02**)<br>Middle tertile psoas size (vs smallest tertile): 0.5 (0.4-0.7) (**p<0.001**)<br>Largest tertile psoas size (vs smallest tertile): 0.5 (0.3-0.7) (**p<0.001**)<br>Tokuhashi score: 0.9 (0.85-0.97) (**p<0.001**) | |
| | | <u>Post-operative Neurological Function</u><br>Non-significant | | |
| | | <u>Any Complications; OR (95%CI)</u> | <u>Post-operative Neurological Improvement; OR (95%CI)</u><br>Prior stroke: 0.2 (0.04-0.95) (**p=0.04**)<br>Largest tertile psoas size (vs smallest tertile): 4.1 (1.3-13.3) (**p=0.02**) | |

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| | Post-operative neurological improvement<br><br>Postoperative morbidity | Middle tertile psoas size (vs smallest tertile): 0.5 (0.3-0.9) (**p=0.03**)<br>Tokuhashi score: 1.1 (1.0-1.3) (**p=0.02**)<br>KPS: 1.0 (1.0-1.1) (**p=0.001**) | <u>Any Complications; OR (95%CI)</u><br>MI/CAD: 2.9 (1.2-7.4) (**p=0.02**)<br>Chronic renal disease: 3.0 (1.1-8.8) (**p=0.04**) | |
| Zaw *et al Transfusion* **2017** (Singapore)[61] | Overall survival | <u>OS; HR(95%CI)</u><br>Pre-op ECOG: 1.2 (1.04-1.4) (**p=0.01**)<br>Gender (Male): 1.4 (1.03-1.9) (**p=0.02**) | <u>OS; HR (95%CI)</u><br>Pre-op ECOG: 1.2 (1.04-1.4) (**p=0.01**) | Median OS: 15mo (11-21)<br>Overall PFS: 6mo (3-6)<br>Median PFS: 6mo<br>@12m: 51% alive |
| Zhang *et al World Neurosurg* **2019** (China)[63] | Overall survival | Age (<50 vs >50): (**p=0.03**)<br>Pre-op Frankel (A-C vs D-E): (**p=0.02**) | <u>HR (95%CI)</u><br>Age (<50 vs >50): 17.1 (1.1-265.7) (**p=0.04**) | Median OS: 50.2 mo (13-126) |
| Zhang *et al Front Oncol* **2021** (China)[64] | VTE | <u>VTE; OR (95%CI)</u><br>Frankel score (A-C vs D-E): 5.6 (3.0-11.1) (**p=0.001)**<br>Charlson comorbidity index >7 (vs 6 or less): 5.8 (1.4-24.8) **(p=0.02)** | <u>VTE; OR (95%CI)</u><br>Frankel score (A-C vs D-E): 5.6 (3.0-11.1) (**p=0.001)**<br>Charlson comorbidity index >7 (vs 6 or less): 2.3 (1.3-4.2) **(p=0.02)** | Not reported |
| | | *Abbreviations : Abbreviated Injury Scale (AIS), American spinal injury association impairment scale (ASIA-AIS), Alkaline Phosphatase (ALP), American Society of Anesthesiologists (ASA), Body mass index (BMI; reported as kg/m$^2$), Coronary artery bypass grafting (CABG), Coronary artery disease (CAD), Cervical/cervico-thoracic (C/CT), Congestive heart failure (CHF), Confidence interval (CI), Charlson Comorbidity Index (CCI), Disease free survival (DFS), Diabetes mellitus (DM), Chronic obstructive pulmonary disease (COPD), C-reactive protein (CRP), Eastern Cooperative Oncology Group Performance Status (ECOG), Group (grp), Hemoglobin (Hb), Hypertension (HTN), Hazard ratio (HR), Japanese Orthopedic Association (JOA), Karnofsky Performance Score (KPS), Lactate Dehydrogenase (LDH), Length of stay (LOS), Metastatic epidural spinal cord compression (MESCC), Myocardial infarction (MI), Modified Rankin score (mRS), Not significant (NS), Oswestry Disability Index (ODI), Odd ratio (OR), Overall survival (OS), Progression free survival (PFS), Patients (pts), Radiotherapy (RT), Risk ratio (RR), Spinal cord injury measure (sCIM), Standard error (SE), Short-Form 36 (SF-36v2), Spinal instability neoplastic score (SINS), Surgical site infection (SSI), Visual analogue scale (VAS), Venous thromboembolism (VTE), With (w), Without (w/o). | | |