Article published online: 2022-10-07



# Impact of Obesity on Perioperative Complications on Treatment of Spinal Metastases: A Multicenter Surveillance Study from the German Spine Registry (DWG-Register)

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AJNS 2022;17:442–447.

## Abstract

**Background** The spine is a common location for the development of primary and metastatic tumors, spinal metastases being the most common tumor in the spine. Spinal surgery in obesity is challenging due to difficulties with anesthesia, intravenous access, positioning, and physical access during surgery. The objective was to investigate the effect of obesity on perioperative complications by discharge in patients undergoing surgery for spinal metastases.

**Methods** Retrospective analysis of data from the DWG-register on patients undergoing surgery for metastatic disease in the spine from January 2012 to December 2016. Preoperative variables included obesity ($\geq 30\ kg/m^2$), age, gender, and smoking status. In addition, the influence of pre-existing medical comorbidity was determined, using the American Society of Anesthesiologists (ASA) score.

**Results** In total, 528 decompressions with and without instrumentation undergoing tumor debulking, release of the neural structures, or tumor extirpation in metastatic disease of the spine were identified; 143 patients were obese (body mass index [BMI] $\geq 30\ kg/m^2$), and 385 patients had a BMI less than $30\ kg/m^2$. The mean age in the group with BMI $30\ kg/m^2$ or higher (group 1) was 67 years (56.6%). In the group with BMI less than $30\ kg/m^2$ (group 2), the mean age was 64 years. Most of the patients had preoperatively an ASA score of 3 and 4 (patients with severe general disease). The likelihood of being obese in the logistic regression model seems to be protective by 47.5-fold for blood loss 500 mL or higher. Transfusions occurred in 321/528 (60.7%) patients (group 1, $n = 122$ and group 2, $n = 299$; $p = 0.04$). A total of

**Keywords**
- obesity
- metastases
- spinal surgery
- register

**DOI** https://doi.org/10.1055/s-0042-1756627.
**ISSN** 2248-9614.



Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

19 vertebroplasties with percutaneous stabilization (minimally invasive spine [MIS]), 6 vertebroplasties, and 31 MIS alone were identified. The variables between these groups, with exception of preoperative status (ASA-score; $p = 0.02$), remained nonsignificant.

**Conclusion** Obese patients were predisposed to have blood loss more than 500 mL more often than nonobese patients undergoing surgery for spinal metastases but with perioperative blood transfusions, invasiveness, nor prolonged hospitalization. Early postoperative mobilization and a low threshold for perioperative venous thromboembolism (VTE) are important in obese patients to appropriately diagnose, treat complications, and minimize morbidity.

## Background

The spine is a common location for the development of primary and metastatic tumors. Spinal metastases are the most common tumor in the spine, accounting for more than 95% of spinal tumors and more than 18,000 newly diagnosed cases in North America each year.[1] Surgical indications for spinal metastases have expanded over the past few years to address symptoms of neurological deficit and spinal instability.[2]

Obesity is a national epidemic, and according to the Centers for Disease Control and Prevention, among 78 million American adults, 35.7% of the population is currently obese (i.e., body mass index [BMI] $\geq 30\,kg/m^2$). Spinal surgery in the setting of obesity is challenging due to difficulties with anesthesia, intravenous access, positioning, and physical access during the surgery itself.[3] Furthermore, obesity represents a systematic inflammatory state that can affect postoperative recovery and fusion rates, which could be particularly detrimental for patients with spinal metastases who are frail and have poor physiological reserve.[3] Although several studies have demonstrated an increased risk of perioperative complications in patients with obesity, other studies have shown contradicting findings.[4]

There are currently very few studies in the literature analyzing the relationship between obesity and perioperative outcomes following surgery for metastatic spinal tumors.[5] The objective of this study was to investigate the effect of obesity on perioperative complications by discharge in patients undergoing surgery for spinal metastases.

## Methods

This study is a retrospective analysis of data from the "DWG-Register" on patients undergoing surgery for metastatic disease in the spine at 10 institutions from January 2012 to December 2016.

Patient recruitment at the 10 institutions in Germany was performed with the permission of the Ethics Committee of the concerning federal state medical association (MC 23/2017).

Preoperative variables included obesity ($\geq 30\,kg/m^2$) age, gender, and smoking status. In addition, the influence of preexisting medical comorbidity determined, using the American Society of Anesthesiologists (ASA) score, was also considered as a predictor variable.

The inclusion criteria were patients between 18 and 90 years of age, undergoing spinal surgery for metastatic disease suffering paresis, deformity, pain, and/or bladder and bowel dysfunction from cervical spine to S1. Since 2012, pre-, intra-, and postoperative data have been continuously collected in the "DWG-Register" (a total of 24,640 in the period from 1/1/2012 to 31/12/2016). In total, 528 decompressions with and without instrumentation undergoing tumor debulking, release of the neural structures, or tumor extirpation in metastatic disease of the spine were identified in the registry; 143 patients were obese (BMI $\geq 30\,kg/m^2$), while 385 patients had a BMI less than $30\,kg/m^2$. There were a total of 19 vertebroplasties with percutaneous stabilization (minimally invasive spine [MIS]), 6 vertebroplasties, and 31 MIS alone identified. They will be analyzed separately.

### Statistical Analysis

The statistical program JMP-15[6] was used to perform the analysis of descriptive statistics, providing values of central tendency and dispersion such as mean and standard deviation of all the variables (Bartlett's test for homoscedasticity is automatically performed by the JMP-15 program). For the comparative analysis, Student's *t*-test for normally distributed continuous variables or the Wilcoxon/Kruskal–Wallis test for non-normally distributed continuous variables were used. For categorical variables, the chi-squared test was applied, and for tables with cells less than 5 Fisher's exact test was utilized. Statistical significance was defined as $p$ less than 0.05. The odds ratio (OR) and relative risk with 95% confidence intervals (CI) were calculated. Using these data, it was possible to determine the risk of surgical site infection related to surgical invasiveness. A logistic regression analysis with the variables that showed a significant difference ($p < 0.05$) was also performed. In the final model, the results are expressed in the study with OR (95% CI).

## Results

The mean age in the group with BMI $30\,kg/m^2$ or higher (group 1) was 67 years; men were more frequently affected

 

**Table 1** Demographics, clinical evaluation, location, and preoperative characteristics from obese patients undergoing decompression with and without instrumentation in metastatic spine disease

| | Group 1 ($n = 143$) | Group 2 ($n = 385$) | $p$-Value |
|---|---|---|---|
| Gender (M/F) | 81/62 | 226/159 | 0.67 |
| Age (years) (median, range) | $67 \pm 12$ | $64 \pm 12$ | 0.06 |
| **Preoperative status** | | | |
| ASA Score 1[a] | 19 (13.2%) | 32 (8.3%) | |
| ASA Score 2 | 1 (0.7%) | 10 (2.5%) | |
| ASA Score 3 | 37 (25.8%) | 136 (35.3%) | |
| ASA Score 4 | 82 (57.3%) | 196 (51%) | |
| Not documented | 4 (2.7%) | 11 (2.8%) | 0.06 |
| Previous surgeries at the same level | 17 (11.8%) | 64 (16.6%) | 0.22 |
| **Preoperative therapeutic goals** | | | |
| Pain improvement | 87 (60.8%) | 211 (54.8%) | 0.20 |
| Paresis improvement | 47 (32.8.8%) | 150 (40%) | 0.19 |
| Bowel and bladder dysfunction improvement | 7 (4.8%) | 39 (10.1%) | 0.04 |
| Smokers (yes/no/unknown) | 95/38/10 | 92/236/57 | $< 0.001$ |

Significant differences between the groups were determined by chi-squared test or Fisher's exact test for dichotomized or categorical data. Continuous data were obtained using the independent sampling Student's $t$-test or Mann-Whitney U-test.
[a]American Society Anesthesiologist status score.

(56.6%) than women. In the group with BMI less than 30 kg/m$^2$ (group 2), the mean age was 64 years with men in this group being more frequent (58.7%) than women. Most of the patients had preoperatively an ASA score of 3 and 4 (patients with severe general disease) according to the underlying disease (neoplasm): 451/528 (85.4%) (group 1, $n = 119$ and in group 2, $n = 332$) (►**Table 1**). The number of smokers shows a difference between groups being more common in nonobese patients (group 2). The number of patients with previous lumbar surgeries at the same level did not show a significant difference between groups. In general, the preoperative characteristics of the patients and clinical evaluation did not show a significant difference between studied groups. Credentials (operation being performed from another surgeon than a spinal surgeon, neurosurgeon, orthopaedist, resident of neurosurgery or resident of orthopaedics) ($p$-value = 0.55) seem to be nonsignificant (see ►**Table 1**). The variables between vertebroplasty with MIS, vertebroplasty and MIS alone groups with exception of preoperative status (ASA-score; $p = 0.02$) remained nonsignificant.

Superficial wound infections of surrounding skin and subcutaneous tissue occurred in 15/528 (2.8%) patients. A deep wound infection, defined as an infection that penetrates the muscle fascia, occurred in 3/528 (0.6%) with no statistical significance between the groups. Nerve injury with avulsion of the nerve root occurred in six patients in group 2 (►**Table 2**).

Dural tear (DT) occurred in 13/528 (2.4%) of the included patients. The difference in the incidence of DT between these two surgical procedures was not statistically significant. Blood loss greater than 500 mL occurred in 177/528 (33.5%) (group 1, $n = 33$ and group 2, $n = 144$; $p < 0.001$). The likelihood of being obese in the logistic regression model seems to be protective by 47.5-fold for blood loss of 500 mL or more. Transfusions occurred in 321/528 (60.7%) (group 1; $n = 122$ and group 2; $n = 299$; $p = 0.04$). With regard to perioperative complications, we attempted to analyze and establish variables associated with blood loss greater than 500 mL. These were attachment of tumor at the dura (likelihood of 7.23-fold for blood loss greater than 500 mL), operation time more than 3 hours (likelihood of 93.7-fold), and stabilization with stab and pedicle screw system (likelihood of 4.44-fold). Active smoking seems to bias the obtained results, with the number of smokers in the nonobese group being higher than in the obese group.

## Discussion

Perioperative complication rates following surgery for spinal metastases are high[7] Previous studies have reported an average perioperative complication rate of 26.9%, with rates ranging from 5.3 to 76.2%.[6,7] Studies have also reported on multiple risk factors for increased morbidity following surgery for metastatic spinal lesions, which include age, multilevel disease, preoperative radiation, surgeon experience, and myelopathy.[8–13] However, obesity has been poor studied as a potential risk factor for surgical complications following operative decompression of metastatic spinal tumors.

Cancer patients also have an increased risk of venous and arterial thrombosis. Mortality rates of cancer patients with a venous thromboembolism (VTE) are higher than in those patients without VTE.[14–20]

In our multivariate analysis, we did find an association between obesity and perioperative blood transfusions.

 

**Table 2** Operative, postoperative variables, and complications from obese patients undergoing decompression with and without instrumentation in metastatic spine disease

| | Group 1 ($n = 143$) | Group 2 ($n = 385$) | *p*-Value |
|---|---|---|---|
| Decompression/stabilization | 42/101 | 117/268 | 0.87 |
| Surgery extension from/to (average) | Th2/L5 (Th7) | Th2/S1 (Th7) | 0.68 |
| Anterior access | 23 (16.1%) | 16 (12.7%) | 0.07 |
| **Technology** | | | |
| Microscope | 37 (25.8%) | 52 (24.6%) | 0.77 |
| Neuromonitoring | 9 (6.3%) | 8 (5.2%) | 0.62 |
| **Intraoperative complications** | | | |
| Operation time > 3 hours | 73 (51%) | 205 (53.2%) | 0.13 |
| Nerve injury | 0 | 6 (1.5%) | 0.06 |
| Dura injury | 3 (2.1%) | 10 (2.5%) | 0.38 |
| Blood transfusion | 33 (23.1%) | 144 (57.3%) | < 0.001 |
| Blood loss > 500 mL | 122 (85.3) | 299 (77.6%) | 0.04 |
| **Postoperative complications** | | | |
| Thromboembolic event | 3 (2.1%) | 0 | 0.03 |
| Paresis | 1 (7%) | 3 (7.8%) | 0.41 |
| Superficial wound infection | 3 (2.1%) | 12 (3.1%) | 0.51 |
| Deep wound infection | 1 (0.7%) | 2 (0.5%) | 0.81 |
| Epidural hematoma drain | 2 (1.4%)1351 | 3 (0.8%) | 0.58 |
| Death | 2 (1.4%) | 9 (2.3%) | 0.42 |
| **Hospitalary stay** | | | |
| 1. Eventless | 104 (73.7%) | 268 (71.2%) | |
| 2. ICU > 2 days | 6 (4.2%) | 18 (4.8%) | |
| 3. Long stay (> 2 weeks) | 33 (23%) | 98 (26.1%) | 0.52 |

Abbreviation: ICU, intensive care unit.

Surprisingly, obese patients had a significantly lower rate of blood transfusions (23.1%) compared with their nonobese counterparts (57.3%) which is consistent with previous studies that have found transfusion rates of 8 to 36% in patients undergoing spinal surgery suffering obesity, with a tendency toward higher transfusion rates in oncological spinal surgery.[21–23] Furthermore, obese patients have a higher estimated blood volume, and therefore, the amount of blood lost as a proportion of estimated blood volume is lower for obese patients compared with that of nonobese patients that require a blood transfusion, although in our study, the proportion of blood loss more than 500 mL in our obese patients was higher (85.3%), compared with nonobese patients (77.6%). Those findings between blood loss more than 500 mL and blood transfusion could be explained as follows: Nonobese patients suffering from a neoplastic disease, in general, are found in an advanced stadium with malnutrition organic failure and a lower KPC (Karnofsky Performance Status), prone to become infectious disease such pneumonia and poor vascular status after repeatedly chemotherapy, requiring more often blood transfusion by lower blood loss amounts. Similar to our findings, Cheung et al found that there was a significant decrease in the rate of perioperative blood transfusions following laminectomy for spinal metastases in patients with increased BMI.[21–24] These findings suggest that the percentage of estimated blood loss may be more predictive of blood transfusion requirements, which may offer a plausible explanation for the lower rate of perioperative transfusions observed in our cohort of obese patients.

In the present study, there was no significance found if a minimally/less invasive surgical approach was used. It has been seen in other pathologies such as degenerative spinal canal stenosis in the lumbar spine with no difference between decompression alone and stabilization.[12,25]

Obese patients had the same incidence of prolonged hospitalization compared with nonobese patients. This is an unexpected finding that is difficult to explain, as previous studies examining outcomes after spinal surgery have found an association between obesity and prolonged hospitalization.

There are several limitations to the present study. First, "DWG-Register" database is subject to various biases—including selection bias and sampling bias—that are inherent

 

in all studies that are based on data from registries. The "DWG-Register" database classifies cases based on Current Procedural Terminology (CPT) codes. However, CPT codes do not provide information about histology, which is a significant prognostic predictor.[26–28] The overall burden of disease and number of visceral metastases has also been associated with poor prognosis but could not be analyzed with our dataset.[29,30] Additionally, prognostic variables such as KPC or postoperative functional status (e.g., paraparesis, paraplegia) were not available in the "DWG-Register" database. Chemotherapy and radiation therapy were also not accounted for in this database. Another limitation is that outcomes were limited to discharge with no long-term follow-up. In this study, obesity was defined as a dichotomous variable only, and we did not subcategorize patients further according to the degree of obesity due to the small number of patients that would have been in each subgroup. Future studies should examine long-term outcomes of surgery in obese patients with spinal metastases, as well as assess the effect of increasing severity of obesity on surgical outcomes.

With these limitations in mind, the "DWG-Register" database provides a large sample size from multiple institutions nationwide to investigate the impact of obesity following surgery for spinal metastases. Findings demonstrate that obesity is an independent predictive risk factor for VTE but also a risk factor for any other major perioperative complications excluding blood transfusion.

## Conclusion

Obese patients were predisposed to have more often blood loss more than 500 mL that nonobese patients surgery for spinal metastases but with perioperative blood transfusions, invasiveness nor prolonged hospitalization. Early postoperative mobilization and a low threshold to evaluate for perioperative VTE are important in obese patients to appropriately diagnose, treat complications, and minimize morbidity.

### Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

### Informed Consent

Informed consent was obtained from all individual participants included in the study.

### Availability of Data and Material

The datasets generated and/or analyzed during the current study are available in the (DWG-register home page) repository [https://dwg.memdoc.org/].

### Funding

None.

### Conflict of Interest

None declared.

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