



Original Article

# Strategies for posterior-only minimally invasive surgery in thoracolumbar metastatic epidural spinal cord compression

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## ABSTRACT

**Background:** Metastatic epidural spinal cord compression (MESCC) is a debilitating sequela of cancer. Here, we evaluated various subtypes of posterior-only minimally invasive spinal (MIS) procedures utilized to address different cancers.

**Methods:** Within this retrospective review, we analyzed the treatment of thoracolumbar MESCC treated with three MIS techniques: decompression and fusion (Subgroup A), partial corpectomy (Subgroup B), and full corpectomy (Subgroup C).

**Results:** There were 51 patients included in the study; they averaged 58.7 years of age, and 51% were females. Most tumors were in the thoracic spine (51%). The average preoperative Frankel grade was D (62.7%); 69% (35) improved postoperatively. The patients were divided as follows: subgroup A (15 patients = 29.4%), B (19 patients = 37.3%), and C (17 patients = 33.3%). The length of hospitalization was similar (~5.4 days) for all groups. The overall complication rate was 31%, while blood loss was lower in Subgroups A and B versus C.

**Conclusion:** Different MIS surgical techniques were utilized in patients with thoracic and/or lumbar MESCC. Interestingly, clinical outcomes were similar between MIS subgroups, in this study, with a trend toward higher complications and greater blood loss associated with those undergoing more aggressive MIS procedures (e.g., full corpectomy and fusion).

**Keywords:** Corpectomy, Metastasis, Metastatic epidural spinal cord compression, Minimally invasive spine, Spine surgery, Thoracolumbar

## INTRODUCTION

The thoracolumbar spine is the most common osseous site for malignant neoplasm metastasis<sup>[13]</sup>, occurring in approximately 30–40% of patients with advanced cancer and more frequently in patients with pre-existing non-spinal bony metastasis.<sup>[8]</sup> Radiographically, metastatic epidural spinal cord compression (MESCC), is defined as an epidural metastatic lesion causing displacement of the thecal sac and contents.<sup>[6]</sup> Radiation and increasingly chemotherapy is a cornerstone of the treatment plan for patients with MESCC.<sup>[6]</sup> Although surgery is often palliative,

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indications include intractable pain, instability, and presence of neurological deficit, with patient considerations based on expected survival time, Karnofsky performance score and disease burden.<sup>[11,12]</sup> Minimally invasive spine surgery (MIS) is being increasingly utilized for patients with MESCC.<sup>[8]</sup> Here, we focused on three different types of posterior-only MIS approaches to the thoracolumbar spine for the treatment of MESCC: decompression and fusion (Subgroup A), partial corpectomy (Subgroup B), and full corpectomy (Subgroup C).

## MATERIALS AND METHODS

### Patient selection

Institutional review board approval was obtained for a retrospective review of patients treated from June 2006 to July 2017. Patients underwent clinical evaluations and MRI and CT studies. The three different posterior MIS techniques were employed: posterior tubular decompression and percutaneous instrumented fusion (Subgroup A), tubular partial corpectomy and percutaneous instrumented fusion (Subgroup B), or tubular complete transpedicular or costotransverse corpectomy and percutaneous instrumented fusion (Subgroup C). The decision-making process utilized: Karnofsky performance status (KPS), patient age, neurological deficit, vertebral body involvement, and spinal instability neoplastic score. The 51 patients included, in this study, had thoracic and/or lumbar disease. Patients with previously diagnosed renal cell carcinoma underwent preoperative endovascular tumor embolization. Multiple variables were collected for each patient and are included in [Table 1]. Intraoperative neurophysiological monitoring was performed on all 51 patients.

Fifteen patients (29.4%) were in Subgroup A, 19 (37.2%) in Subgroup B, and 17 (33.3%) in Subgroup C. The average follow-up period was  $18.5 \pm 24.2$  months for all patients. The mean number of levels instrumented was 2, 3, and 4 in Subgroups A-C, respectively [Table 2].

### Surgical approaches

- Surgery A: Tubular laminectomy and percutaneous instrumented fusion

Patients are placed prone and intraoperative fluoroscopy is used to aid with percutaneous screw placement. When deemed appropriate, polymethylmethacrylate (PMMA) pedicle screw augmentation was employed as previously described<sup>[4,5]</sup>. Decompressive laminectomy is performed using a 24 mm diameter tube in conjunction with intraoperative microscopy. Following decompression, percutaneous rod placement is performed bilaterally.

- Surgery B: Partial corpectomy and percutaneous instrumented fusion

**Table 1:** Patient characteristics and outcomes.

| Variable                          | Value       |
|-----------------------------------|-------------|
| Age (years) (mean (SD))           | 58.7 (13.6) |
| Female (n [%])                    | 26 (51%)    |
| Spinal level (n [%])              |             |
| Thoracic                          | 26 (51%)    |
| Lumbar                            | 15 (29.4%)  |
| Thoracolumbar                     | 10 (19.6%)  |
| Number of levels (Med [IQR])      | 4 (2)       |
| Primary tumor (n [%])             |             |
| Breast                            | 9 (17.6%)   |
| Renal cell                        | 8 (15.7%)   |
| Multiple myeloma                  | 7 (13.7%)   |
| Lung                              | 6 (11.8%)   |
| Prostate                          | 4 (7.8%)    |
| Other                             | 17 (33.3%)  |
| Surgery type (n (%))              |             |
| Subgroup A                        | 15 (29.4)   |
| Subgroup B                        | 17 (33.3)   |
| Subgroup C                        | 19 (37.3)   |
| Preop Frankel grade (n [%])       |             |
| A-B                               | 3 (5.9%)    |
| C                                 | 9 (17.6%)   |
| D                                 | 32 (62.7%)  |
| E                                 | 7 (13.7%)   |
| KPS (Med [IQR])                   | 70 (20)     |
| Blood loss (ml) (mean [SD])       | 1226 (1633) |
| Instrumentation failure (n [%])   | 3 (5.9)     |
| Overall complications (n [%])     | 16 (31.4)   |
| Length of stay (days) (mean [SD]) | 5.4 (4.4)   |
| Postop Frankel grade (n [%])      |             |
| A-B                               | 2 (3.9%)    |
| C                                 | 2 (3.9%)    |
| D                                 | 15 (29.4%)  |
| E                                 | 32 (62.7%)  |
| Average follow-up (months)        | 18.5 (23.8) |

Values are n (%) or mean (SD) or median. IQR: Inter quartile range

Screw placement was performed as described above. The unilateral 24 mm diameter tube was used to visualize and remove the lamina and tumor from the dorsal thecal sac, and the transpedicular avenue was utilized to remove bone and tumor anteriorly. If less than 50% of the vertebral body is involved, a partial corpectomy is performed followed by injection of PMMA into the cavity held in place through Steinman pin. Rods are then placed as described above.

- Surgery C: Complete transpedicular corpectomy and percutaneous instrumented fusion

The procedure is performed as described in "Surgery B." In addition, an expandable port is utilized to perform the majority of the transpedicular corpectomy [Figure 1]. A 24 mm tube is used on the contralateral side to remove residual vertebral body. In cases, where marked intraoperative bleeding during the corpectomy is encountered, even after

**Table 2:** Comparison of patient variables and outcomes by MIS operation subtype.

| Variable                          | All groups  | Subgroup A (n=15) | Subgroup B (n=19) | Subgroup C (n=17) |
|-----------------------------------|-------------|-------------------|-------------------|-------------------|
| Age (years) (mean [SD])           | 58.7 (13.6) | 61 (10)           | 58 (15)           | 57 (15)           |
| Female (n [%])                    | 26 (51%)    | 8 (55.3%)         | 8 (42.1%)         | 10 (59%)          |
| Number of levels (Med (IQR))      | 4 (2)       | 2 (1)             | 3 (2)             | 4 (1)             |
| Spinal level (n [%])              |             |                   |                   |                   |
| Thoracic                          | 26 (51%)    | 5 (33.3%)         | 13 (68.4%)        | 8 (47.1%)         |
| Lumbar                            | 15 (29.4%)  | 7 (3%)            | 3 (15.8%)         | 5 (29.4%)         |
| Thoracolumbar                     | 10 (19.6%)  | 3 (20%)           | 3 (15.8%)         | 4 (23.5%)         |
| Preop Frankel grade (n [%])       |             |                   |                   |                   |
| A-B                               | 3 (5.9%)    | 1 (6.7%)          | 2 (10.5%)         | 0 (0%)            |
| C                                 | 9 (17.6%)   | 3 (20%)           | 5 (26.3%)         | 1 (5.9%)          |
| D                                 | 32 (62.7%)  | 9 (60%)           | 10 (52.6%)        | 13 (76.5%)        |
| E                                 | 7 (13.7%)   | 2 (13.3%)         | 2 (10.5%)         | 3 (17.6%)         |
| KPS (Med [IQR])                   | 70 (20)     | 70 (30)           | 70 (20)           | 70 (15)           |
| Blood loss (ml) (mean (SD))       | 1226 (1633) | 581 (497)         | 818 (1872)        | 2251 (1570)       |
| Hardware failure (n [%])          | 3 (5.9)     | 1 (6.7%)          | 1 (5.2%)          | 1 (5.9%)          |
| Recurrence rate (n [%])           | 3 (5.9)     | 0 (0%)            | 1 (5.2%)          | 2 (11.7%)         |
| Infection (n [%])                 | 1 (2%)      | 0 (0%)            | 0 (0%)            | 1 (5.9%)          |
| Overall complications (n [%])     | 16 (31.4)   | 3 (20%)           | 5 (26.3%)         | 9 (52.9%)         |
| Length of stay (days) (mean (SD)) | 5.4 (4.4)   | 5.8 (4.7)         | 4.6 (2.4)         | 6.4 (5.6)         |
| Postop Frankel grade (n [%])      |             |                   |                   |                   |
| A-B                               | 2 (3.9%)    | 1 (6.7%)          | 1 (5.3%)          | 0 (0%)            |
| C                                 | 2 (3.9%)    | 0 (0%)            | 2 (10.5%)         | 0 (0%)            |
| D                                 | 15 (29.4%)  | 6 (40%)           | 5 (26.3%)         | 4 (23.5%)         |
| E                                 | 32 (62.7%)  | 8 (53.3%)         | 11 (57.9%)        | 13 (76.5%)        |
| Improvement in Frankel grade      | 35 (69%)    | 10 (67%)          | 14 (74%)          | 11 (65%)          |

Values are n (%) or mean (SD) or median. IQR: Inter quartile ranges

preoperative embolization, a contralateral transpedicular injection of PMMA into the cancellous vertebral body offers a significant reduction in intraoperative bleeding. After the corpectomy is completed an expandable vertebral body reconstruction cage is deployed. Rods are then placed as described above.

## RESULTS

Preoperative functional status was collected using the Frankel grade and KPS. Patients had a mean preoperative KPS of 70, and overall had a 69% improvement in Frankel grades postoperatively [Figure 2 and Table 2]. Notably, there was a slightly higher improvement rate of 74% in Subgroup B versus Subgroups A and C (67% and 65%, respectively). No patients deteriorated postoperatively. The average blood loss was 581 ml, 818 ml, and 2251 ml in Groups A-C, respectively [Figure 2 and Table 2]. The mean LOS were (LOS) 5.4 days, and 5.8, 4.6, and 6.4 days in Groups A-C, respectively [Table 2].

## Complications

There were 16 postoperative complications 3 (20%) in Subgroup A, 5 (26%) in Subgroup B, and 9 (53%) in Subgroup

C [Figure 3 and Table 2]. Infection occurred in one Subgroup C patient, and instrumentation failure requiring revision occurred in three patients (one from each group). Although patient selection attempted to include only those with an expected survival of greater than 3-months, two patients (4%) died from disease progression within 30-days, one in each Subgroups B and C [Figure 3]. Although predictions are made by a multidisciplinary team, MESCC patient course can be unpredictable. Tumor recurrence was observed in one patient in Subgroup B (5.2%) and two patients in Subgroup C (11.7%).

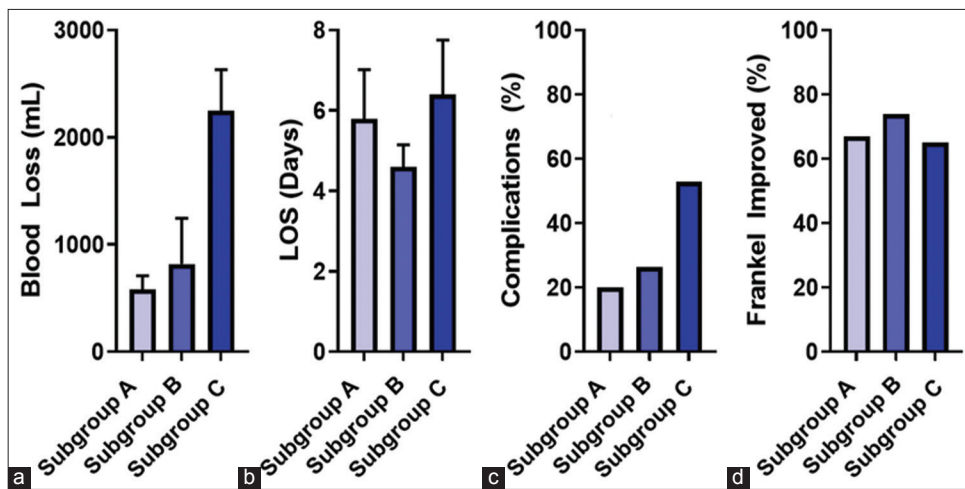
## DISCUSSION

Spinal epidural metastatic disease develops in up to 36% of patients with malignancy.<sup>[13]</sup> The most common tumors to metastasize to the spine include breast, prostate, and lung, with 10% of these patients developing symptomatic MESCC.<sup>[9]</sup> The distribution of disease is highest in the thoracic (50%), followed by the lumbar (30%) and cervical spine (10–15%).<sup>[1]</sup> More recently, minimally invasive surgical techniques (MIS) have been employed for the treatment of MESCC.<sup>[9]</sup>

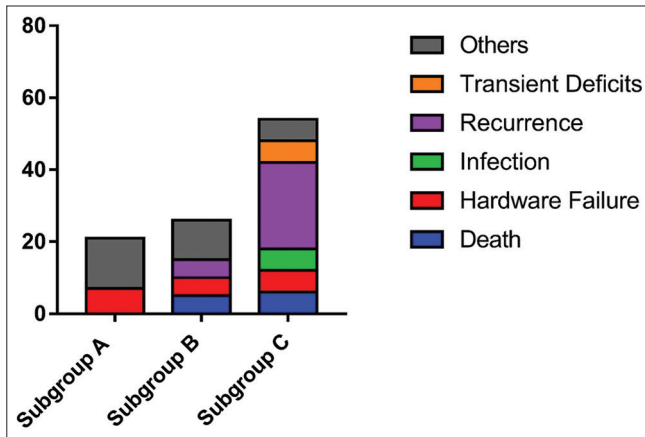
The versatility of MIS approaches has significantly advanced in the past decade and has allowed for the



**Figure 1:** Case example of metastatic epidural spinal cord compression from a breast cancer primary tumor with low back pain, cauda equina symptoms, and right-sided L4 radiculopathy. (a and b) An MRI T1 sequence with gadolinium is shown with an L4 vertebral body enhancing lesion with canal compression and a predominantly lytic component on sagittal CT. (c) Intraoperatively, an expandable VBR cage is placed after corpectomy and removal of posterior elements through an expandable port. (d) The VBR cage is seen from the contralateral side after further decompression is performed through a 24 mm tube. (e and f) Postoperative X-ray AP and lateral images show L4 VBR cage with L2 to S1 posterior instrumentation.



**Figure 2:** Comparison of blood loss (a), length of stay (b), complication rate (c), and rate of Frankel grade improvement (d) by MIS surgery subtype. Subgroup A=Posterior decompression and fusion, Subgroup B=Partial corpectomy and fusion, and Subgroup C=Full corpectomy and fusion.



**Figure 3:** Complication rates in Subgroups A, B, and C. There was no statistically significant difference between the groups in complication rates, but there was a trend toward higher complication rates with Subgroup C compared to Subgroups A and B. Other complications include two cases of postoperative ileus, seroma formation requiring re-operation, and one case of pleural effusion requiring chest-tube placement.

expansion of surgical approaches from less to more aggressive in nature. The least invasive approach is the posterior tubular decompression and percutaneous instrumented fusion (Subgroup A), Next, is the tubular partial corpectomy and percutaneous instrumented fusion (Subgroup B). The most aggressive MIS surgery in this cohort is tubular complete transpedicular or costotransverse corpectomy and percutaneous instrumented fusion (Subgroup C).

Overall functional improvement occurred in all three patients cohorts (e.g., 69%), which compared favorably with published data (20–76.5%),<sup>[3,10]</sup> the average blood loss in Subgroups A (581 ml) and B (818 ml) was comparable to that in the literature, and lower than the average found in the open surgery (714–2450 ml and 1125–1500 ml, respectively)<sup>[2,7]</sup> the complication rate was twice as high in Subgroup C patients compared to the other subgroups. Furthermore, Subgroup C patients had greater surgical complication, instrumentation failure, and 30-day mortality rates than the other subgroups in addition to longer hospital LOS. In some cases such as significant anterior column disruption, aggressive surgical intervention may be mandated, however, when using posterior-based MIS approaches for the treatment of MESCC, more conservative approaches (Subgroups A and B) offer similar functional outcomes with less morbidity than the more aggressive treatment strategies (Subgroup C).

## CONCLUSION

In our single-institution, MIS cohort, we demonstrate the versatility of various posterior-only MIS approaches for the

treatment of MESCC. However, the more aggressive the MIS procedure the greater the complication rates without an improvement in functional outcomes.

## Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

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Nil.

## Conflicts of interest

Dr. Frankel receives royalties from Orthofix and Stryker.

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