Surgical or Radiation Therapy for the Treatment of Cervical Spine Metastases: Results From the Epidemiology, Process, and Outcomes of Spine Oncology (EPOSO) Cohort

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Abstract

Study Design: Ambispective cohort study design.

Objectives: Cervical spine metastases have distinct clinical considerations. The aim of this study was to determine the impact of surgical intervention (+ radiotherapy) or radiotherapy alone on health-related quality of life (HRQOL) outcomes in patients treated for cervical metastatic spine tumours.

Methods: Patients treated with surgery and/or radiotherapy for cervical spine metastases were identified from the Epidemiology, Process, and Outcomes of Spine Oncology (EPOSO) international multicentre prospective observational study. Demographic, diagnostic, treatment, and HRQOL (numerical rating scale [NRS] pain, EQ-5D (3L), SF-36v2, and SOSGOQ) measures were prospectively collected at baseline, 6 weeks, 3 months, and 6 months postintervention.

Results: Fifty-five patients treated for cervical metastases were identified: 38 underwent surgery + radiation and 17 received radiation alone. Surgically treated patients had higher mean spinal instability neoplastic scores compared with the radiation-alone group (13.0 vs 8.0, \(P < .001\)) and higher NRS pain scores and lower HRQOL scores compared to the radiation alone group (\(P < .05\)). From baseline to 6 months posttreatment, surgically treated patients demonstrated statistically significant improvements in NRS pain, EQ-5D (5L), and SOSGOQ2.0 scores compared with nonsignificant improvements in the radiotherapy alone group.

Conclusions: Surgically treated cervical metastases patients presented with higher levels of instability, worse baseline pain and HRQOL scores compared with patients who underwent radiotherapy alone. Significant improvements in pain and HRQOL were noted for those patients who received surgical intervention. Limited or no improvements were found in those treated with radiotherapy alone.

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Keywords
spine oncology, cervical metastases, surgery, radiotherapy

Introduction
Cervical spine metastases represent only 8% to 15% of all spinal metastases; however, they require a distinct clinical perspective considering the complex biomechanics of the cervical spine and often have worse prognoses compared with thoracic and lumbar metastatic disease.1-6 The intricate neurological, vascular, and visceral anatomy presents unique challenges to both the surgeon and the radiation oncologist for the management of metastases in this region.7-9 The main goal of treatment for patients with metastatic spinal disease is to improve pain and maintain or improve neurological function and health-related quality of life (HRQOL).10 Generally, indications for surgical management are progressive neurological deficits resulting from compression of neural structures, intractable pain, and spinal instability.11-13 The indications for radiotherapy alone include pain without myelopathy or instability.14 The potential collateral damage to critical organs as a result of surgical or radiation treatment limit treatment options and stress the necessity for multidisciplinary management.

To date, there has been a paucity of literature and no prospective studies investigating HRQOL and adverse event outcomes in this unique patient population treated with radiation and/or surgery. Epidemiology, Process, and Outcomes of Spine Oncology (EPOSO) is a comprehensive, prospective clinical observational study aimed at collecting patient, diagnostic and treatment variables along with disease-specific and HRQOL data on consecutively treated patients with metastatic spine tumors. This is a subgroup analysis of the larger EPOSO cohort with the main objective of the study being to determine the impact of surgical intervention (± radiotherapy) and radiotherapy alone on HRQOL outcomes in patients treated for cervical metastatic spine tumors. A secondary aim of this study is to identify treatment specific adverse events during follow-up.

Materials and Methods

Patient Population and Study Design
The AOSpine Knowledge Forum Tumor initiated an international, multicenter, prospective observational study between August 2013 and February 2017 at 10 spine centers across North America and Europe (ClinicalTrials.gov identifier NCT01825161). This study was complete with full ethics approval from the University of British Columbia Clinical Ethics Review Board (Number: H13-00980). Study population included all consecutively treated patients from participating centers diagnosed with metastatic spine tumors who had undergone surgery and/or radiotherapy for the treatment of spinal metastases from any primary tumor and were aged 18 to 75 years. Patients with a primary spinal bone tumor or central nervous system tumor were excluded. The ethics board of each participating center approved the protocol. All patients provided written informed consent for study participation.

A subgroup of patients with cervical spine metastases treated with either surgical intervention (± radiotherapy) or radiotherapy alone was identified from the above cohort. Demographic, diagnostic information, and disease-specific and generic HRQOL data was collected prospectively and analyzed retrospectively representing an ambispective study design.

All patients enrolled underwent treatment with either surgical intervention (± radiotherapy) or radiotherapy alone as per individual institution protocol. Adverse event and clinical data was collected prospectively and entered into the EPOSO database. All treatment was at the discretion of the most responsible clinician including surgical instrumentation, post-operative management (including wound management and VTE prophylaxis), and dose and duration of radiotherapy.

Outcome Measures
Outcome measures data was collected at enrollment and follow-up scheduled at 6, 12, and 26 weeks following the initiation of treatment for cervical metastases. The pain numerical rating scale (NRS) visual analog scale was used for the evaluation of pain.15-17 Patients were assessed for HRQOL using the EQ-5D (5L)18, and the SF-36v2 Questionnaire.19 Disease-specific HRQOL was evaluated with the Spine Oncology Study Group Outcomes Questionnaire (SOSGOQ2.0).20,21

Statistical Analysis
All statistical analyses were performed using SAS version 9.4 (SAS Institute, Cary NC). Simple summary statistics were used to report all outcome measures’ endpoints by treatment group. Differences in baseline parameters were analyzed by using a t test or Wilcoxon rank sum test for continuous variables, whereas the chi-square test or Fisher’s exact test were used for categorical variables. A mixed effect model was used to test for differences in outcomes compared to baseline for each treatment and considered missing data during follow-up. Significance was defined as P < .05.

Results

Demographics
A total of 55 patients were identified from the EPOSO cohort, 38 (69.1%) of which received surgical intervention (± radiotherapy) and 17 (30.9%) received radiotherapy alone. The mean patient age was 57.4 (SD 10.9) years and 50.9% (n = 28) were male. The 3 most common types of primary cancer were breast (n = 15), lung (n = 15), and kidney (n = 5). The most common location for metastatic disease in the cervical
spine was the cervicothoracic junction with 35 (63.6%) of patients having burden of disease between C6 and C7 (Table 1).

Of the 55 patients, 20 (36.4%) of the experience only axial pain, 8 (14.5%) had only radicular pain, 20 patients (36.4%) had both axial and radicular pain, and 7 (12.7%) experienced no pain. There were no patients with complete neurological deficits (American Spinal Injury Association Impairment Scale [AIS] A) and all those who underwent radiotherapy alone were graded as AIS E (Table 1). Patients who received surgical intervention (+ radiotherapy) had a higher mean spinal instability neoplastic score (SINS) than radiotherapy alone (13.0 vs 8.0, \( P < .001 \)) and presented more often with mechanical neck pain before intervention (89.5% vs 37.5%, \( P < .001 \)). Two illustrative cases are presented in Figures 1 and 2.

Table 1. Demographic and Clinical Information for All Patients With Cervical Metastatic Disease.

|                          | All (N = 55) | Surgery ± Radiation (n = 38) | Radiation (n = 17) | \( P \) |
|--------------------------|--------------|------------------------------|--------------------|------|
| Mean Age (SD)            | 57.4 (10.9)  | 57.0 (10.9)                  | 58.4 (7.9)         | .641 |
| Gender, n (%)            |              |                              |                    |      |
| Male                     | 28 (50.9)    | 21 (55.3)                    | 7 (41.2)           | .334 |
| Female                   | 27 (49.1)    | 17 (44.7)                    | 10 (58.8)          |      |
| Primary tumor type, n (%)|              |                              |                    | .126 |
| Breast                   | 15 (27.3)    | 10 (26.3)                    | 5 (29.4)           |      |
| Lung                     | 15 (27.3)    | 10 (26.3)                    | 5 (29.4)           |      |
| Myeloma                  | 3 (5.5)      | 3 (7.9)                      | 0 (0)              |      |
| Kidney                   | 5 (9.1)      | 1 (2.6)                      | 4 (23.5)           |      |
| Prostate                 | 3 (5.5)      | 2 (5.3)                      | 1 (5.9)            |      |
| Other                    | 14 (25.5)    | 12 (31.6) \( ^a \)          | 2 (11.8) \( ^b \)  |      |
| Primary tumor removed, n (%)|            |                              |                    |      |
| No                       | 25 (45.5)    | 22 (57.9)                    | 3 (17.6)           |      |
| Yes—totally             | 23 (41.8)    | 11 (28.9)                    | 12 (70.6)          |      |
| Only partial             | 6 (10.9)     | 4 (10.5)                     | 2 (11.8)           |      |
| Unknown                  | 1 (1.8)      | 1 (2.6)                      | 0 (0)              |      |
| Pain type, n (%)         |              |                              |                    |      |
| None                     | 7 (12.7)     | 1 (2.6)                      | 6 (35.3)           |      |
| Axial                    | 40 (72.7)    | 32 (84.2)                    | 8 (47.1)           |      |
| Radicular                | 20 (35.5)    | 22 (57.9)                    | 6 (35.3)           |      |
| Location of tumor, n (%) |              |                              |                    |      |
| Occiput-C2               | 8 (14.5)     | 7 (18.4)                     | 1 (5.9)            |      |
| C3-5                     | 27 (49.1)    | 16 (42.1)                    | 11 (64.7)          |      |
| C6-7                     | 35 (63.6)    | 24 (63.2)                    | 11 (64.7)          |      |
| ASIA Impairment Scale (AIS), n (%)| | | | |
| A                        | 0 (0.0)      | 0 (0.0)                      | 0 (0.0)            |      |
| B                        | 2 (3.7)      | 2 (5.3)                      | 0 (0.0)            |      |
| C                        | 5 (9.3)      | 5 (13.2)                     | 0 (0.0)            |      |
| D                        | 13 (24.1)    | 13 (34.2)                    | 0 (0.0)            |      |
| E                        | 34 (63.0)    | 18 (47.4)                    | 16 (100.0)         |      |
| Pain type, n (%)         |              |                              |                    |      |
| Pain-free lesion         | 4 (7.4)      | 0 (0.0)                      | 4 (25.0)           | <.001 |
| Occasional pain but not mechanical | 10 (18.5) | 4 (10.5) | 6 (37.5) |      |
| Mechanical pain          | 40 (74.1)    | 34 (89.5)                    | 6 (37.5)           |      |
| Epidural compression, n (%)|            |                              |                    | .025 |
| No compression (grade 0) | 12 (23.1)    | 5 (13.5)                     | 8 (46.7)           |      |
| Compression present (grade 1a/b/c, 2, 3) | 40 (76.9) | 32 (86.5) | 9 (53.3) |      |
| SINS, mean (SD)          | 11.5 (3.6)   | 13.0 (2.8)                   | 8.0 (2.8)          | <.001 |

Abbreviations: ASIA, American Spinal Injury Association; SINS, spinal instability neoplastic score.

\( ^a \) 3 \times \) myeloma, 6 \times \) gastrointestinal, 1 \times \) thyroid, 1 \times \) uterine, 1 \times \) liver, 2 \times \) bladder, and 1 \times \) oropharynx.

\( ^b \) 1 \times \) gastrointestinal and 1 \times \) bladder.

Surgical Details

A total of 38 patients underwent surgical intervention, 23 (60.5%) patients had a posterior surgical approach, 9 (23.6%) had an anterior approach, and only 6 (15.8%) had a combined approach. The mean operating time was 236.5 (SD 109.8) minutes and included a median of 4 spinal levels instrumented (Table 2). In the surgical treatment group, 25 (65.8%) patients had radiotherapy, of whom 11 (44.0%) had adjuvant radiotherapy, which began at mean 1.5 (SD 1.0) months after surgery.

Radiotherapy Details

Considering the 17 patients who only received radiotherapy, 9 (52.9%) underwent conventional radiotherapy and 8 (47.1%)
received multifraction stereotactic radiotherapy. The median radiation dose for conventional radiotherapy was 20 Gy in 5 fractions. The median radiation dose in the stereotactic radiation group was 24 Gy in 2 fractions (Table 3).

Patient-Reported Outcomes Assessment

The patients who received surgery (± radiotherapy) had higher pain NRS scores (7.4 vs 3.4, \( P < .001 \)), worse EQ-5D scores (0.43 vs 0.65, \( P < .006 \)), and worse SOSGOQ2.0 scores (45.9 vs 61.4, \( P = .004 \)) at baseline compared to those who received radiotherapy alone. Neither the physical component summary nor the mental component summary of the SF-36v2 demonstrated statistically significant differences postintervention from baseline in the surgical treatment (± radiotherapy) or radiation alone groups at 6 months postintervention (Table 4).

Surgery (± Radiotherapy) Patient-Reported Outcomes Assessment

In those who received surgical intervention, there were statistically significant improvements in pain compared with baseline at 6 weeks (7.4 vs 4.5, \( P < .001 \)), 3 months (7.4 vs 4.7, \( P = .006 \)), and 6 months (7.4 vs 4.5, \( P = .002 \)) posttreatment. Also, significant improvements in EQ-5D (5L) scores from baseline at 6 weeks (0.43 vs 0.61, \( P = .036 \)), 3 months (0.43 vs 0.64, \( P = .020 \)), and 6 months (0.43 vs 0.67, \( P = .003 \)) posttreatment were observed. Finally, improvements in the total score of the SOSGOQ2.0 from baseline were seen in the surgery (± radiotherapy) group at 6 weeks (45.9 vs 61.8, \( P = .008 \)), 3 months (45.9 vs 67.9, \( P < .001 \)), and at 6 months (45.9 vs 69.9, \( P < .001 \)) postoperatively.

All individual domains of the SOSGOQ2.0 showed improvement for the surgery (± radiotherapy) group, including physical function, pain, social function, and mental health, except for the neurological function. The pain domain demonstrated the greatest degree of improvement between all domains with an observed median of 30 points improvement at 6 months posttreatment.

Radiation Patient-Reported Outcomes Assessment

Those patients who received radiotherapy alone demonstrated no significant changes in NRS pain scores from baseline at 6

Figure 1. A 75-year-old woman with metastatic breast carcinoma, presenting with neck pain and no neurological symptoms. She received palliative radiation treatment to the cervical spine. She received 1800 cGy in 4 fractions.

Figure 2. A 63-year-old man with metastatic bladder carcinoma. He presented with mechanical neck pain, bilateral leg paresthesias, and hyperreflexia. Imaging demonstrated destruction of the C3 vertebral body with significant focal kyphosis and posterior subluxation of C2 into C3. He underwent an anterior C3 and C4 vertebral body resection, decompression spinal cord, and osteotomy with anterior correction of kyphosis. Anterior cage C2-5 with cement and plate C2-5.
weeks (3.4 vs 2.3, \( P = .798 \)), 3 months (3.4 vs 3.2, \( P = 1.000 \)), and 6 months (3.4 vs 3.5, \( P = 1.000 \)) posttreatment (Table 4). There were no significant improvements in ED-5D (5L) scores noted at 6 weeks (0.65 vs. 0.68, \( P = 1.000 \)), 3 months (0.65 vs 0.70, \( P = .995 \)), and 6 months (0.65 vs 0.71, \( P = .990 \)) posttreatment. Finally, no improvement was seen in the total score of SOSGOQ2.0 from baseline in the radiotherapy only group at 6 weeks (61.4 vs 64.1, \( P = 1.000 \)), 3 months (61.4 vs 66.2, \( P = .979 \)), and 6 months (61.4 vs 72.1, \( P = .613 \)) (Table 4).

**Table 2. Surgical Data and Details for Patients Treated With Cervical Metastatic Disease.**

| Characteristic | Surgery ± Radiation (N = 38) |
|---------------|-----------------------------|
| Approach, n (%) | Radiation Therapy Only         |
| Anterior       | 9 (23.7)                    |
| Posterior      | 23 (60.5)                   |
| Combined anterior/posterior | 6 (15.8)       |
| Surgical levels, median (range) | 4.0 (1-8)     |
| Surgical time, min, mean (SD) | 236.5 (109.8) |
| Length of stay, days, median (range) | 8.0 (2-26)  |
| Previous radiation therapy, n (%) | 8 (21.1)       |
| Adjunct radiation therapy, n (%) | 11 (28.9)      |
| Start of adjuvant radiotherapy, months, mean (SD) | 1.5 (1.0)     |
| Postsurgical adverse event, n (%) | 17 (44.7)      |
| Dural tear     | 1 (2.6)                     |
| Implant comp   | 1 (2.6)                     |
| Massive blood  | 1 (2.6)                     |
| Vascular injury| 1 (2.6)                     |
| Postsurgical adverse event, n (%) | 3 (8.1)        |
| Dysphasia/dysphonia | 1 (2.6)     |
| Pneumonia      | 2 (5.3)                     |
| Thromboembolic event | 4 (10.5) |
| Urinary tract infection | 4 (10.5) |
| Wound drainage | 4 (10.5)                    |
| Wound infection | 2 (5.3)                     |

**Table 3. Radiotherapy Data and Details for Those Who Received Radiation Therapy Only.**

| Type, n (%) | Radiation (N = 17) |
|------------|--------------------|
| Conventional | 9 (52.9)             |
| Total dose, Gy, median (range) | 20.0 (18-30)        |
| Number of fractions, median (range) | 5.0 (4-10)   |
| Stereotactic | 8 (47.1)             |
| Total dose, Gy, median (range) | 24.0 (24 – 28)      |
| Number of fractions (range) | 2.0 (2 – 3)        |
| Adverse events, n (%) | 8 (47.1)         |
| Skin         | 3 (17.6)              |
| Mucous membrane | 2 (11.8)            |
| Pharynx and esophagus | 4 (23.5)          |
| Upper gastrointestinal | 3 (17.6)            |
| Lower gastrointestinal (including pelvis) | 2 (11.8) |
| Hemoglobin drop | 1 (5.9)              |
| Platelet drop | 1 (5.9)               |

**Adverse Events**

Postoperative adverse events occurred in 17 out of 38 (44.7%) and intraoperative events occurred in 4 (10.5%) of surgical patients. Intraoperative events included dural tear, implant complication and bleeding complications. Postoperative events included thromboembolic events, wound complications, infections, neurologic deterioration, and dysphasia (see Table 2). Radiation adverse events occurred in 11 out of 25 (44.0%) surgical patients and 8 out of 17 (47.1%) radiation only patients with the three most reported being gastrointestinal symptoms, dermatologic manifestations, and blood dyscrasias (see Table 3).

**Dropout and Death**

At 6-month follow-up, 5 (13.2%) patients were lost to follow-up and 14 (36.8%) had died in the surgery (± radiotherapy) group. In the radiation alone group, 3 (17.6%) were lost to follow-up and 4 (23.5%) had passed away at the time of 6-month follow-up.

**Discussion**

The goal of treatment for metastatic disease to the cervical spine is that of neurologic and functional recovery with relief of pain to improve or maintain HRQOL. The results of this study demonstrate that those selected for surgical treatment (± radiotherapy) for cervical spine metastatic disease achieve improvement in pain and HRQOL at all time points up to and including 6 months follow-up. It also demonstrates that those who received radiotherapy alone in cervical metastatic disease did not show improvement in pain or HRQOL at any follow-up time point and overall maintain these scores at 6 months. This is probably related to different treatment indications and outcome objectives. For example, local control may be a primary indication for radiation, to prevent worsening symptoms down the road.

Indications for surgical intervention have traditionally included neurologic compromise from neural compression, spinal instability, and intractable pain. In the surgical group from the current study, patients demonstrated worse baseline pain and function scores and were likely selected for surgical treatment based on mechanical pain, instability, and associated neurologic compromise. Patients who received surgical intervention demonstrated significant improvements in pain and HRQOL (EQ-5D (5L) and SOSGOQ2.0) and maintained these improvements over 6 months. This is consistent with what has been reported in numerous retrospective studies demonstrating improvements in pain and HRQOL with surgical intervention for cervical metastases, but none using prospectively collected data. 

This study represents a large international collaboration and one of the first prospective cohorts that has used validated and reliable generic and disease-specific HRQOL measures to follow patients with spinal metastases.

The purpose of this study was not to directly compare radiation with surgery for cervical metastases as the 2 groups are not...
similar at baseline. Surgical intervention is thus an appropriate option and beneficial to patients who demonstrate symptoms of spinal instability and neurologic compromise, improving overall patient quality of life and pain symptoms.

Indications for radiation therapy alone are pain with no signs of myelopathy or mechanical instability. There have been all patient quality of life and pain symptoms, spinal instability and neurologic compromise, improving over time. Surgical intervention is thus an appropriate option for those who fail to respond to other treatment modalities may provide improvement in quality of life, disability, and pain for those who fail to respond to radiotherapy.

Cervical spine metastasis poses a significant challenge to clinicians due to numerous factors including complex anatomy, proximity to neurovascular structures, and diverse patient populations with varying prognoses. Differences with regard to anatomy and complexity exist based on region in the cervical spine which include occipito-cervical junction (C0-C2), subaxial spine (C3-C6), and the cervico-thoracic junction (C7-T2). Because of this complexity, surgery and radiotherapy can lead to significant adverse events. In this study, those who received surgery had a postoperative complication rate of 44.7%. These included pneumonia, urinary tract infection, wound complications, thromboembolic events, and others. In the literature, complication rates for surgical management of cervical metastatic spine disease range from 10% to 52% and are consistent with our findings. Those in the radiation alone group demonstrated adverse events in

Table 4. Mixed Effects Model Demonstrating Patient-Reported Outcomes Estimates.a

|                  | Surgery ± Radiation | Radiation | Surgery vs Radiotherapy |
|------------------|---------------------|-----------|-------------------------|
|                  | n Mean (95% CI)     | n Mean (95% CI) | n Mean (95% CI) | Adjusted P^b | Adjusted P^b | Adjusted P^b | P^c |
| **Pain NRS**     |                     |           |                        |              |              |              |     |
| Baseline         | 35 7.4 (6.5; 8.2)   | 17 3.4 (2.2; 4.5) | <.001              |              |              |              |     |
| 6 weeks          | 25 4.5 (3.4; 5.5)   | 12 2.3 (0.9; 3.8) | .006               |              |              |              |     |
| 12 weeks         | 17 4.7 (3.6; 5.8)   | 11 3.2 (1.8; 4.5) | .006               |              |              |              |     |
| 26 weeks         | 13 4.5 (3.3; 5.7)   | 7 3.5 (1.9; 5.1) | .006               |              |              |              |     |
| **EQ-5D (3L)**  |                     |           |                        |              |              |              |     |
| Baseline         | 34 0.43 (0.34; 0.52)| 17 0.65 (0.53; 0.78)| .006              |              |              |              |     |
| 6 weeks          | 24 0.61 (0.51; 0.70)| 12 0.68 (0.55; 0.81)| .004              |              |              |              |     |
| 12 weeks         | 17 0.64 (0.56; 0.73)| 11 0.70 (0.59; 0.82)| .004              |              |              |              |     |
| 26 weeks         | 13 0.67 (0.59; 0.75)| 7 0.71 (0.60; 0.81)| .004              |              |              |              |     |
| **SF-36v2 PCS**  |                     |           |                        |              |              |              |     |
| Baseline         | 35 30.0 (26.6; 33.5)| 17 35.3 (30.4; 40.3)| .006              |              |              |              |     |
| 6 weeks          | 23 28.5 (24.2; 32.8)| 12 34.0 (28.2; 39.8)| .004              |              |              |              |     |
| 12 weeks         | 17 32.8 (28.4; 37.2)| 10 34.5 (28.8; 40.1)| .004              |              |              |              |     |
| 26 weeks         | 13 31.2 (25.5; 37.0)| 7 34.9 (27.2; 42.6)| .004              |              |              |              |     |
| **SF-36v2 MCS**  |                     |           |                        |              |              |              |     |
| Baseline         | 35 42.3 (37.8; 46.7)| 17 45.7 (39.3; 52.1)| .382              |              |              |              |     |
| 6 weeks          | 23 44.8 (39.5; 50.1)| 12 47.8 (40.5; 55.2)| .131              |              |              |              |     |
| 12 weeks         | 17 44.1 (39.5; 48.7)| 10 46.0 (40.0; 52.0)| .636              |              |              |              |     |
| 26 weeks         | 13 47.6 (40.9; 54.3)| 7 45.5 (36.5; 54.6)| .434              |              |              |              |     |
| **SOSGOQ2.0**   |                     |           |                        |              |              |              |     |
| Baseline         | 33 45.9 (39.9; 52.0)| 17 61.4 (53.0; 69.8)| .004              |              |              |              |     |
| 6 weeks          | 22 61.8 (53.5; 70.1)| 11 64.1 (52.6; 75.5)| .748              |              |              |              |     |
| 12 weeks         | 16 67.9 (60.6; 75.1)| 10 66.2 (56.9; 75.5)| .772              |              |              |              |     |
| 26 weeks         | 13 69.9 (62.3; 77.4)| 7 72.1 (61.8; 82.3)| .724              |              |              |              |     |

Abbreviations: NRS, numerical rating scale; EQ-5D (3L), EuroQol-5D (3L); SF-36, Short Form–36; PCS, physical component summary; MCS, mental component summary; SOSGOQV2.0, Spine Oncology Study Group Outcomes Questionnaire version 2.0.

^a Boldfaced P values indicate statistical significance (P < .05).

^b Adjusted P value by Tukey-Kramer for comparison of change to baseline value per treatment group.

^c P value for comparison of mean value of both treatment groups.
47.1% of patients and 44.0% of patients in the surgical group who received radiotherapy. These included upper gastrointestinal symptoms, dermatologic manifestations, and blood dyscrasias. The complications from surgical intervention, such as pulmonary embolism or wound complication, have the potential for significant repercussions including harm to life or need for reoperation, while complications from radiation therapy, report no major complications. However, in patients treated surgically for metastatic spine disease, the complications for surgical intervention have been shown to not impact mortality post-intervention and that the 30-day morbidity rate was substantially higher in those receiving radiation therapy. Thus, the decision to undergo surgical intervention must take into consideration the adverse event profile and is best approached by a multidisciplinary team including spine surgeons, radiation oncologists, and medical oncologists in discussion with patients’ and families’ wishes.

While this is an international multicenter collaboration involving 10 centers, a limitation of this study is the small sample size of only 55 patients with cervical metastases, making it difficult to evaluate and limit the ability to adjust for confounding variables such as the differences in SINS, pain, and HRQOL scores at baseline between the two treatment groups. This study was not a comparative study and selection for treatment was based on the discretion of the treating physician. Thus, the 2 groups must be looked at individually and baseline differences between the two treatment groups should be considered when interpreting the results. In addition, the differences within the anatomical regions of the cervical spine could not be further evaluated as a small sample size made interpretation of the results challenging. Finally, the choice of surgical technique and approach could not be standardized and is often based on surgical experience, location of the tumor, and guided by the literature. Specifics surrounding the type of instrumentation used, construct design, and implant technology were not available for review from the data collection and cannot be explicitly commented on.

Conclusions
This ambispective analysis of patients who underwent surgical and/or radiation treatment for cervical metastatic spine disease demonstrates that patients who received surgical intervention have worse baseline disease-specific and generic HRQOL and pain scores when compared to those who underwent radiotherapy only. Those who received surgical treatment for cervical metastases have significant improvements after surgery at 6 weeks with sustained results at 3 and 6 months posttreatment. Therefore, in patients presenting with cervical metastatic spine disease that is amenable to surgery, surgical intervention can significantly improve pain and HRQOL. Future studies should focus on identifying which patients are best selected for surgical intervention and evaluating the variations in outcomes for discrete anatomic regions of the cervical spine.

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