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Stereotactic Body Radiation Therapy in Nonsurgical Patients with Metastatic Spinal Disease and Epidural Compression: A Retrospective Review

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■ BACKGROUND: **In the setting of spinal metastases with epidural cord compression, radiosurgery is often only considered when there is sufficient separation between the epidural disease and the spinal cord. However, in patients who are nonsurgical candidates or those who prefer nonoperative management, there may be a benefit from stereotactic body radiation therapy, even when the epidural target is closer than the traditionally referenced 3 mm distance from the spinal cord. The purpose of this retrospective study is to evaluate our institution's experience in treating 20 such patients.**

■ METHODS: **We reviewed records of all patients treated with stereotactic body radiation therapy for spinal metastases at our institution from January 2010 to January 2016, with follow-up through December 2016. The primary end point was local progression of disease. Local progression was defined as clear radiographic disease growth on follow-up imaging or worsening clinical symptoms in the absence of evidence for radiation myelopathy.**

■ RESULTS: **Local control was obtained in 55% of patients meeting these criteria without a single case of radiation myelitis. Most patients with disease progression were able to undergo additional local treatment.**

■ CONCLUSIONS: **Although local control was less than expected when compared with spine radiosurgery with adequate separation between the target and spinal cord, this treatment appears to be a viable option in the nonsurgical candidate.**

INTRODUCTION

The treatment of metastatic spinal disease with epidural cord compression is a well-debated and continually evolving topic within neurosurgical oncology. Typically, treatment of these patients involves surgery, radiation therapy (RT), or both.[1-4] Choice of treatment depends on factors such as medical operability, life expectancy, intra- and extracranial disease control, performance status, neurologic status, and spinal stability. An interdisciplinary team should discuss all relevant issues to determine the best treatment algorithm for the patient. There are certain emergent situations where prompt surgical intervention is mandated, particularly patients presenting with epidural spinal cord compression (ESCC) resulting in new or progressive neurologic deficits.[5-7] RT also plays an essential role in the management of patients with spine metastases. It is commonly used for the palliation of painful bone metastases and to relieve symptoms

Key words
- Epidural disease
- Malignant spinal cord compression (MSCC)
- Spinal metastases
- Stereotactic ablative body radiotherapy (SABR)
- Stereotactic body radiation therapy (SBRT)

Abbreviations and Acronyms
BED: Biologically effective dose
CT: Computed tomography
EQD2: Equivalent doses in 2 Gy
ESCC: Epidural spinal cord compression
MRI: Magnetic resonance imaging
RT: Radiation therapy
RTOG: Radiation Therapy Oncology Group
SABR: Stereotactic ablative body radiotherapy
SBRT: Stereotactic body radiation therapy
SINS: Spinal Instability Neoplastic Score

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related to malignant spinal cord compression.[1,3,8,9] RT for spine metastases is often delivered with conventionally fractionated radiotherapy. Recently, there have been substantial technologic advances in RT beyond conventional 2-dimensional treatment. Newer modalities, including 3-dimensional conformal radiation therapy, intensity-modulated radiation therapy, image-guided radiation therapy, and stereotactic body radiation therapy (SBRT), also known as stereotactic ablative body radiotherapy (SABR), have been instrumental in the treatment of epidural disease. In particular, SBRT/SABR allows radiation oncologists to deliver a high dose of radiation per fraction with millimeter accuracy.[10,11] With such treatment, durable local control of spinal metastases may exceed 90%. This benefit is independent of histology, providing excellent palliation and long disease-free intervals.[12]

Currently, the Radiation Therapy Oncology Group (RTOG) is conducting a study randomizing patients to either SBRT (16–18 Gy in 1 fraction) or conventional RT (8 Gy in 1 fraction).[13] This clinical trial outlines potential guidelines to follow when assessing a suitable patient for treatment with spine SBRT, one of which is to have a 3-mm gap or larger between the spinal cord and the edge of the epidural tumor. This gap, or separation, is important to minimize dose-related injury to the spinal cord, which can result in iatrogenic radiation myelopathy. The separation also prevents potential spinal cord compression and neurologic deficits secondary to RT-induced edema. Although the extent of epidural disease typically dictates whether surgical intervention is warranted, patient comorbidities and health status may preclude surgical intervention. Therefore, there may be a select group of patients presenting with spinal metastases and epidural disease within 3 mm of the spinal cord who may benefit from SBRT. The purpose of this study is to retrospectively investigate the outcomes of patients at our institution who had less than 3 mm separation between the spinal cord and the edge of the epidural lesion and received SBRT.

PATIENTS AND METHODS

In this institutional review board–approved study (protocol number 2013003977), we reviewed records of all patients treated with SBRT for spinal metastases at our institution from January 2010 to January 2016, with follow-up through December 2016.

The primary end point was local progression of disease. Local progression was defined as clear radiographic disease growth on follow-up imaging or worsening clinical symptoms in the absence of evidence for radiation myelopathy. Inclusion criteria included the following: 1) patients with epidural compression and 3 mm gap or less between the spinal cord and the edge of the epidural lesion, 2) patients who were evaluated and deemed nonoperative candidates by a neurosurgeon or orthopedic surgeon because of medical comorbidities or who had refused surgical management, and 3) patients with no prior surgery at the treated level. Patients who were previously irradiated at the involved level were included as long as they met the other inclusion criteria. Exclusion criteria included the following: 1) patients who were operated on at the spinal level of radiation treatment, 2) patients who did not have a posttreatment magnetic resonance imaging (MRI) or documentation of follow-up, and 3) patients who did not complete the course of radiation treatment. Patients that were included in the study had the pre- and posttreatment MRI reviewed by a radiologist and neurosurgeon.

An epidural compression grade was then calculated and assigned using the previously published ESCC scale.[14] Scans and charts were reviewed to attain radiographic and clinical parameters for calculation of the Spinal Instability Neoplastic Score (SINS).[15] Further data extrapolated from the chart review were chief complaint preradiation and if the patient had relief postradiation. Other covariates extracted for each patient included age, sex, tumor histology, primary vertebral level (defined as whether most vertebral bodies treated were situated in the cervical vs. thoracic vs. lumbar regions), RT dose (Gy), and number of RT fractions delivered. For patients who were found to have treatment failure via MRI, the location of the site of progression was compared with each patient's treatment plan. Patients were then categorized as to whether the failure site received the full prescription dose (in field), was in the dose fall-off region (near miss), or received only scatter radiation dose (out of field).

For lesions at T4 and below, patients were immobilized supine in a stereotactic CIVCO (Orange City, Iowa, USA) body frame. For lesions T3 and above, an Aquaplast (Avondale, Pennsylvania, USA) mask with shoulder immobilization was used. Computed tomography (CT) simulation was performed with the patient in the treatment position with 1.25-mm slice thickness for imaging of the entire spine. Gross tumor volume was defined as gross visible tumor on the planning CT and MRI scans. Most patients were treated in accordance with the International Spine Radiosurgery Consortium consensus guidelines,[16] with an additional clinical target volume expansion to include the entire involved segment (i.e., entire vertebral body covered for an anterior vertebral body metastasis). Planning target volume expansion was 0–2 mm based on physician preference. A helical intensity-modulated RT plan was created using the TomoTherapy planning system (Accuray [Sunnyvale, California, USA]). Patients received a prescription dose determined by the radiation oncologist to cover at least 90% of the defined target volume. For single fraction SBRT, we used constraints from RTOG 0631 with the partial volume spinal cord constraint as 10 Gy to 10% of the spinal cord volume (defined from 5–6 mm above to 5–6 mm below the target volume).[17] The absolute spinal cord dose is 10 Gy to the spinal cord volume to less than 0.35 cm^3. The maximum point dose (less than 0.03 cm^3) was 14 Gy. For patients treated with fractionated SBRT, appropriate dose adjustments were made taking into account previously published guidelines.[18] When the patient had multiple spinal levels treated, the spinal cord constraint was applied to each treated level. The spinal cord volumes were defined based on the image fusion of simulation CT and MRI scans with T2- and T1-weighted images with contrast. In addition to the spinal cord dose volume histogram constraints, the treating physician reviewed each cross-sectional image to check if there was any excessive radiation dose distribution to the spinal cord. Patients had an initial clinical follow-up at 8–10 weeks postspinal SBRT and subsequently had an MRI and clinical follow-up every 3–4 months starting from 12 weeks postspinal SBRT.

Because several dose and fractionation schemes were used, the biologically effective dose (BED) was calculated for each regimen via the linear quadratic model.[19] It was used as an isoeffective dose calculation that estimated the true biologic dose delivered by a

Table 1. Summary Statistics for Categorical Variables

Variable	Category	Number of Patients	%
Sex			
	Male	12	60
	Female	8	40
Race			
	White	11	55
	Nonwhite	9	45
Symptoms			
	No	1	5
	Yes	19	95
ESCC grade pre-SBRT			
	0	0	0
	1a	1	5
	1b	11	55
	1c	4	20
	2	4	20
ESCC grade post-SBRT			
	0	1	5
	1a	3	15
	1b	4	20
	1c	9	45
	2	3	15
Tumor radiosensitivity*			
	Sensitive	13	65
	Resistant	7	35
Fractionation schedule			
	Single	14	70
	Multiple	6	30
Progression			
	No	11	55
	Yes	9	45
Salvage surgery			
	No	16	80
	Yes	4	20
Location			
	Cervical	2	10
	Thoracic	6	30
	Lumbar	11	55
	Sacrum	1	5

ESCC, epidural spinal cord compression; SBRT, stereotactic body radiation therapy.
*Radioresistant tumors were defined as melanoma, sarcoma, renal cell, thyroid, and prostate cancer.

particular combination of dose per fraction and the total dose. The BED was calculated assuming an α/β of 10 representing acute toxicity and responding tumor and an α/β of 3 representing late toxicity. Equivalent doses were calculated in 2 Gy equivalents (EQD2) using the EQD2 equation, using the same α/β values as per the BED calculation.[20]

Summary statistics were provided for both continuous and categorical variables. Logistic regression models were used for the analysis of the associations between response and independent variables. A significance level of 5% was used for all tests. The primary end point was radiographic evidence of disease progression. Other covariates analyzed to examine cohort variation included radiation dosing, tumor radiosensitivity, location of tumor, ESCC grade pre-SBRT, and SINS. We defined radioresistant tumors as melanoma, sarcoma, renal cell, thyroid, or prostate histology, and we defined radiosensitive tumors as lung, breast, lymphoma, and hepatocellular histology.

RESULTS

In our study, after removing patients who did not meet our inclusion criteria (n = 127), a total of 20 patients that received spine SBRT and no preradiation surgery were identified (Table 1). Of these 20 patients, 12 were men and 11 were white. The mean age of the patients in this study was 59.7 years. Median follow-up MRI after treatment was 6 months, with the mean being 8.5 months. The closest follow-up time between treatment and follow-up MRI was 2 months, and the longest time was 47 months. The latter was an outlier because the patient had respiratory issues secondary to her primary disease that made it difficult for the patient to lie flat in the MRI machine. This outlier was removed from the analysis, and subsequently, median follow-up MRI was 6 months with mean of 6.4 months.

In terms of radiation delivery, 6 of 20 patients (30%) received fractionated SBRT, whereas 14 of 20 patients (70%) received a single fraction (Table 2). For single fraction dosing, the delivered dose ranged from 12 to 16 Gy, with median dose of 16 Gy. For multiple fraction schedules, used regimens included 18 Gy in 3 fractions, 24 Gy in 3 fractions, 24 Gy in 4 fractions, and 30 Gy in 5 fractions. The dose and fractionation were dependent on the performing radiation oncologist's preference. BED and EQD2 were calculated for each regimen and are reported in Table 3. In our cohort, there was no statistical significance based on radiation dosing (odds ratio, 0.966; $P = 0.708$) or radiation fractionation (odds ratio, 0.750; $P = 0.769$) on progression (Table 4). Other variables in our analysis of patients with progression of disease are also listed in Table 4.

In our 20-patient cohort, we obtained tumor control in 11 patients (55%) that received upfront radiation and no surgery, whereas 9 patients (45%) had progression of disease (Figure 1). The median time to failure in these patients was 6 months, with a range of 2–11 months. Of the 9 patients that progressed, 4 patients (44.4%) had emergent salvage surgery for neurologic decline, 1 patient (11.1%) chose hospice/palliative care because of global progression of disease, and 4 patients (44.4%) had additional radiation with no surgery. Spinal cord dose constraints were met for every patient as outlined in the Methods section. No patient developed clinical or radiographic symptoms indicative of spinal cord radiation myelitis.

Four patients did undergo surgery post-SBRT (Table 2, patients 5, 8, 9, and 18). All 4 of these patients were technically operative

candidates at time of initial radiation, but declined surgery for personal reasons. Although all were able to have local control with salvage surgical approaches, overall outcomes were variable and limited by short follow-up. Patient 5 was found to progress symptomatically without corresponding MRI evidence and underwent vertebrectomy with improvement of symptoms postoperatively; however, the patient died from progressive systemic disease within 12 months. Patient 8 showed MRI evidence of progression and was treated with laminectomy, which locally controlled the disease; however, the patient died 8 months later from sepsis. Patient 9 underwent laminectomy with local control of disease at most recent follow-up 5 months after surgery. Patient 18 underwent laminectomy 20 months after SBRT with control of disease 5 months postoperatively, but with a great decrease in performance status because of progressing systemic disease.

The patients in our study had various cancer pathologies and radiosensitivities. Based on the tumor subtype, we defined the tumor as either radiosensitive or radioresistant. In our cohort, 7 tumors are considered radiosensitive (35%), whereas 13 are radioresistant (65%). In the patients that progressed, 5 of 9 patients (55.6%) had tumors considered radioresistant, and 4 patients (44.4%) had tumors considered radiosensitive. There was no statistical significance of radiosensitivity of tumor on progression (odds ratio, 0.875; $P = 0.888$). Furthermore, of the 9 patients that had progression of disease, 7 were considered near miss, whereas 2 were considered in field. There were 19 patients who had symptoms of back pain preradiation ranging from radiculopathy to mechanical back pain. Of those 19 patients, radiation provided symptomatic relief for 13 patients (68.4%). Three of the 9 patients (33.3%) with tumor progression had symptomatic relief.

In terms of tumor location (Table 1), 2 of 20 were in the cervical spine, 6 of 20 were in the thoracic spine, 11 of 20 were in the lumbar spine, and 1 of 20 was in the sacrum. There was no statistical significance between spine level treated and progression ($P = 0.615$). Further subgroup analysis of the progressions showed that of 9 patients, 1 started at ESCC grade 1a, 5 started at grade 1b, 1 started at grade 1c, and 2 started at grade 2 (Table 2). In the group of patients who had progression of symptoms postradiation, 4 patients went from ESCC grade 1b to 1c, 1 patient went from ESCC grade 1b to 2, 1 patient stayed at ESCC grade 1a, 1 patient stayed at ESCC grade 1c, and 2 patients stayed at ESCC grade 2. Of the patients that did not progress post-SBRT, 4 of 11 (36.4%) had regression of epidural compression as defined by the ESCC grading. There was no correlation between pre-SBRT ESCC grade and progression (odds ratio, 0.778; $P = 0.822$) (Table 4). Median starting SINS of all patients was 9.0, with a mean score of 8.9. Median

Table 2. Summary of Individual Patient Characteristics and Treatment Outcome

Patient	Treatment Location	Dose (Gy)\Fractions	Histology	Radiosensative	ESCC Score Pre-SBRT	Progression	ESCC Score Post-SBRT	Location of Failure	Salvage Treatment
1	L1	18\3	Prostate	N	1c	No	1c	-	-
2	L1	18\3	Thyroid	N	1c	No	1c	-	-
3*	L2	16\1	Renal	N	1b	Yes	1c	In field	Hospice
4*	T7	24\4	Renal	N	2	Yes	2	Near miss	RT
5*	C7	16\1	Lung	Y	1a	Yes	1a	Near miss	Sx
6	L2	16\1	Prostate	N	1b	No	1b	-	-
7	T2-4	30\5	Lung	Y	1b	No	1a	-	-
8*	L2-4	16\1	Sarcoma	N	1b	Yes	2	In field	Sx/RT
9*	T3-4	16\1	Renal	N	1c	Yes	1c	Near miss	Sx
10	T3	16\1	Renal	N	1b	No	1b	-	-
11	T4-5	16\1	Breast	Y	2	No	1a	-	-
12*	L4	12\1	Breast	Y	1b	Yes	1c	Near miss	RT
13*	L2	16\1	Melanoma	N	1b	Yes	1c	Near miss	RT
14	L3	16\1	Prostate	N	1b	No	1b	-	-
15	S2	30\5	Renal	N	2	No	1c	-	-
16	T6-7	14\1	Sarcoma	N	1b	No	1b	-	-
17	C7	12\1	Lymphoma	Y	1c	No	0	-	-
18*	L1	14\1	HCC	Y	2	Yes	2	Near miss	Sx
19*	L3	24\3	Lung	Y	1b	Yes	1c	Near miss	RT
20	L5	16\1	Melanoma	N	1b	No	1b	-	-

ESCC, epidural spinal cord compression; SBRT, stereotactic body radiation therapy; RT, radiation therapy; Sx, surgery; HCC, hepatocellular carcinoma.
*Patients who were found to have progression.

SINS for those with progression was 9, with the mean being 9.1 (minimum, 6; maximum, 12; standard deviation, 2.1). In our cohort, there was no statistical significance of SINS starting score and progression (odds ratio, 1.173; $P = 0.479$).

DISCUSSION

Surgical intervention and radiosurgery strategies for management of metastatic tumors to the spinal canal continue to evolve. The purpose of this study was to retrospectively evaluate patients in our institution who received SBRT to metastatic spinal lesions with less than a 3-mm gap between the spinal cord and the edge of the epidural lesion. The primary end point was local progression of disease. In our review, we found 20 patients that passed our inclusion/exclusion criteria for the study and were treated with SBRT. Of those 20 patients, there was local tumor control in 11 patients who received upfront radiation and no surgery, whereas 9 patients had progression of disease. Of those 9 patients with disease progression despite SBRT, 4 patients (44.4%) had salvage surgery for neurologic decline or pain, 1 patient (11.1%) chose hospice/palliative care because of global progression of disease, and 4 patients (44.4%) had additional radiation with no surgery. All patients who underwent further surgical salvage were able to obtain local control.

We reviewed tumor pathology and radiation response and noted that 7 patients had tumors considered radiosensitive, whereas 13 patients had tumors considered radioresistant. In the 9 patients with disease progression, 5 patients had tumors considered radioresistant, and 4 had tumors considered radiosensitive. Radiosensitivity of tumor did not show any significant difference between patients that had progression of disease versus those who did not. Dose escalation is a common rationale for the use of stereotactic radiosurgery with radioresistant malignancies; however, this did not seem to improve local control in this patient population. We suggest the reason for this finding may be because of the cold dose crescent at the tumor/cord interface, which may result in such a biologically low dose that both radioresistant and radiosensitive tumors do not undergo adequate cell kill.

Therefore, we then investigated the location of the site of failure in patients with progressive disease. We divided the location of the site of failure into 3 categories: in field for full radiation dose, near miss for tumor receiving partial radiation dose, or out of field meaning it did not receive anything more than scatter radiation dose. Of those 9 patients who experienced disease progression, 7 were considered near miss, whereas 2 were considered in field. There were no out of field progressions in our patient population. Because most of our failures (7/9) were near miss, a review of our treatment plans shows that to respect the dose constraint for the spinal cord, we underdosed the portion of the tumor closest to the spinal cord. This likely resulted in our high failure rate and the frequent utilization of salvage therapies compared with historical results for spine SBRT in patients without epidural or spinal cord compression. We were able to meet our specified constraints for the spinal cord for all patients during treatment, and we saw no evidence of radiation-induced myelitis in our study population. Despite this, the local progression of disease at the interface of the spinal cord could result in additional compression and neurologic compromise. Therefore, both progressive tumor or radiation injury can result in the same functional outcome. The radiation tolerance of the spinal cord is well established; however, future studies could investigate increasing dose to the periphery of the

Table 3. Biologically Effective Dose and Equivalent Dose in 2 Gy for Stereotactic Body Radiation Therapy Prescription Regimens with 2 Conventionally Fractionated External Beam Radiation Therapy Reference Regimens

	$BED_{(3)}$ (Gy)	$BED_{(10)}$ (Gy)	$EQD2_{(3)}$ (Gy)	$EQD2_{(10)}$ (Gy)	Number (%)
SBRT (Gy) with multiple fx					
6 × 5 fx = 30	90	48	54	40	2 (10)
6 × 4 fx = 24	72	38.4	43.2	32	1 (5)
8 × 3 fx = 24	88	43.2	52.8	36	1 (5)
6 × 3 fx = 18	54	28.8	32.4	24	2 (10)
SBRT (Gy) with single fx					
16 × 1 fx = 16	101.3	41.6	60.8	34.7	10 (50)
14 × 1 fx = 14	79.3	33.6	47.6	28	2 (10)
12 × 1 fx = 12	60	26.4	36	22	2 (10)
Conventional EBRT (Gy)					
4 × 5 fx = 20	46.7	28	28	23.3	-
3 × 10 fx = 30	60	39	36	32.5	-

A collection of dose data on all patients treated with spine radiosurgery, divided by multi- and single-fraction schemes. BED and EQD2 calculations reported include both an α/β ratio of 3 (corresponding to late responding tissues) and 10 (corresponding to acute responding tissues) and are denoted in subscript. Two commonly used conventionally fractionated EBRT regimens are also included for reference.

BED, biologically effective dose; EQD2, equivalent dose in 2 Gy; SBRT, stereotactic body radiation therapy; EBRT, external beam radiation therapy; fx, fraction.

Table 4. Data Analysis of Variables on Progression

Variable	Comparison	Odds Ratio	95% CI	*P* Value
Sex				
	Male versus female	0.300	0.046–1.943	0.207
Race				
	White versus nonwhite	0.457	0.076–2.764	0.394
ESCC grade pre-SBRT				
	1 versus 2	0.778	0.087–6.983	0.822
Radiosensitivity				
	Sensitive versus resistant	0.875	0.137–5.576	0.888
Age				
	Per 1-year increment	0.981	0.909–1.059	0.625
Time from initial MRI to follow-up MRI				
	Per 1-day increment	0.860	0.652–1.135	0.287
Time from initial MRI to follow-up MRI (without outlier)				
	Per 1-day increment	0.862	0.648–1.147	0.308
Dose				
	Per 1 dose unit increment	0.966	0.807–1.157	0.708
Fractionation				
	Single versus multiple	0.750	0.110–5.109	0.769
Spine level treated				
	C versus L/S	*	*	0.615†
	T versus L/S	0.357	0.046–2.771	
	C versus T	*	*	
SINS				
	Per 1 score unit increment	1.173	0.754–1.824	0.479

CI, confidence interval; ESCC, epidural spinal cord compression; SBRT, stereotactic body radiation therapy; MRI, magnetic resonance imaging; C, cervical; L, lumbar; S, sacral; T, thoracic; SINS, Spinal Instability Neoplastic Score.
*Sample size was too small to produce meaningful results for odds ratio and CI.
†The produced *P* value is the outcome of whether the spine levels had any effect on progression.

cord—with the goal of improving local control rates while still having acceptable rates of radiation injury.

One of the additional important outcomes that radiosurgery provides is pain control and relief. In our patient population, 19 patients had symptoms of back pain preradiation ranging from radiculopathy to mechanical back pain. Of those 19 patients, radiation provided symptom relief for 13 patients. Furthermore, 3 of the 9 patients with tumor progression experienced symptom relief. Therefore, radiation not only provides local control but also pain control. Although most patients had some pain relief from treatment, only a third of those that recurred had pain relief. This raises the question of whether these patients would have benefited from a larger irradiated volume, over this more conformal treatment.

To achieve better disease control, adjusting dose or contouring during radiation planning may be needed to cover a larger field of tumor burden. In the study by Chan et al.,[21] the authors describe a circumferential donut distribution when planning radiation to the area of the metastatic lesion. It is possible that this type of planning could be more effective in stopping progression of disease in the spine. Despite this, our series compares favorably with the Henry Ford experience reported by Lee et al.,[22] which found that 27% of patients treated with SBRT for high-grade metastatic epidural compression ultimately needed surgical salvage, compared with 20% needing surgical salvage in our series. Although the ongoing RTOG study will help us to better assess the role of SBRT in patients with tumors further from the cord, a randomized trial may be needed in nonoperative candidates with significant epidural extension, such as our cohort.

The main limitation of this study is its retrospective nature and the limited number of patients able to be included. This made

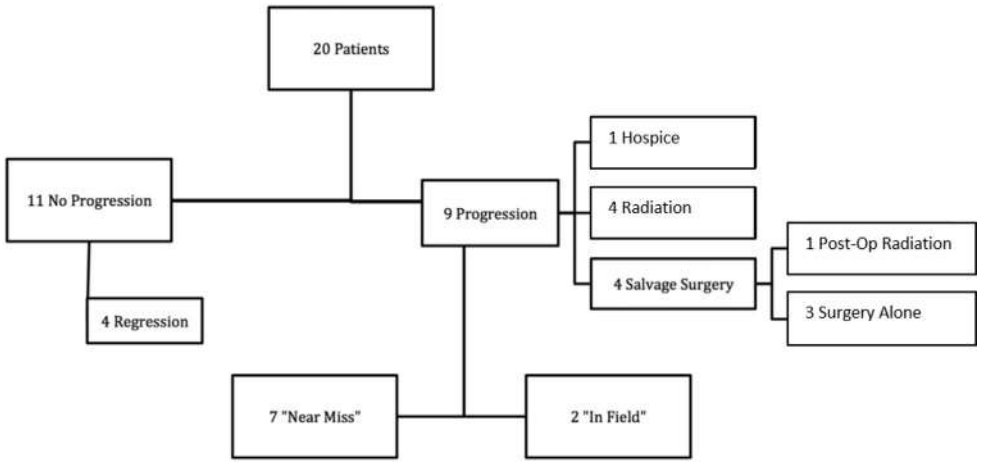

Figure 1. Flowsheet describing patient outcomes. Our cohort consisted of 20 patients. Eleven patients had no progression, with 4 having regression of the tumor after radiation. Nine patients had progression of disease, with 1 opting for hospice, 4 having another course of radiation, and 4 having salvage surgery. Of the 4 patients that had salvage surgery, 1 had postoperative radiation and 3 patients did not have adjuvant radiation after surgery. In the 9 patients with disease progression, analyzing the radiation contouring, 2 treatment plans were considered in field, meaning the tumor received the full gray dose of radiation, and 7 were considered near miss, meaning the tumor received some gray dose of radiation but not the full dose. Post-Op, postoperative.

certain quantitative data analysis difficult, and only qualitative analysis could be performed. Another limitation is the varied radiation dosing patients received. Because the patients were aggregated from a group practice, dosing of tumors depended on the treating radiation oncologist. As such, certain patients with similar pathology had different radiation treatments, and this potentially added variability to the outcome.

Although no patient in our cohort was found to have evidence of radiation myelitis, all other treatment-related toxicity data were not routinely collected and therefore could not be reported in our study. This is a major limitation because spine SBRT is well documented in the literature to cause both acute toxicity, such as temporary pain flair, and chronic toxicity, such as vertebral compression fracture. These events can be fairly common, with vertebral compression fracture rates approaching 11%–39% posttreatment.[23]

Future directions may include an investigation based on the International Spine Radiosurgery Consortium sector model, and whether tumors of a certain sector are more responsive to presurgical radiation, or are at higher risk of failure and progression needing salvage surgery. Hopefully, this single-institution retrospective review begins a discussion of the possible benefits and limitations of radiosurgery in patients who are not surgical candidates.

CONCLUSIONS

In patients with metastatic spinal disease with epidural compression resulting in a distance of less than 3 mm between the target and spinal cord, surgical decompression remains the standard of care. Results from our retrospective investigation suggest that spine SBRT can be considered an alternative to conventionally fractioned radiation in patients who are either nonsurgical candidates, or who refuse surgical intervention. In our small series, radiation did control the disease in most of these patients and may play an important role in aggressive palliation; however, outcomes are less favorable than expected compared with spine radiosurgery in patients without epidural compression.

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