

Single-fraction Stereotactic Body Radiation Therapy (SBRT) using a Simultaneous-Integrated Boost (SIB) Approach for the Treatment of de Novo Spinal Metastases

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Abstract

Objectives: In spine SBRT, the gross tumor volume (GTV) with an osseous margin is often targeted to a single total dose of 16-24 Gy, as per the International Spine Radiosurgery Consortium consensus guidelines (Cox IJROBP 83, 2012). However, it is unclear whether normal bone adjacent to the GTV needs to be treated to such high doses, and this may result in unnecessary increased risk of toxicities such as vertebral compression fracture (VCF). Here we report the outcomes of patients with de novo spinal metastases treated with single-fraction SBRT using a dose-painting SIB technique.

Methods: We performed an IRB-approved, retrospective review of 156 solid tumor spinal metastases from 126 patients treated with single-fraction SBRT using a SIB approach from 2014-2019. Of these, 135 had evaluable follow-up imaging. The most common prescribed dose was 20 Gy (range, 16-25) to the GTV and 14 Gy (range, 13-20) to the clinical treatment volume (CTV) osseous margin. Epidural disease (Bilsky 1a-1c) and spinal cord compression (Bilsky 2-3) were noted in 23% and 5% of the treated lesions, respectively. 45% of the metastases were classified as 'radioresistant.' 21% (n=28) had pre-existing VCF, of which 9 received therapeutic vertebroplasty. 22% (n=30) received prophylactic vertebroplasty, resulting in a total of 29% with vertebroplasty soon after SBRT. Primary endpoints were the cumulative incidences of local failure (LF) and VCF, with death as a competing risk. Secondary endpoints were Kaplan Meier estimates of overall survival (OS) and patient-reported pain improvement. LF and VCF were assessed on imaging, with VCF defined as new or progression of pre-existing fracture after SBRT. Competing risk analyses were performed in R.

Results: With a median follow-up of 12 months, the 1- and 2-year cumulative incidences of LF were 14.2% and 16.7%, respectively, with a 4-month median time to failure. The OS at 1- and 2-years were 64% and 43%, respectively. Of the 74 patients who reported pain prior to radiation, 68% resolved in a median of 4 weeks. Radioresistant lesions (p=0.28), minimum dose to GTV<15Gy (p=0.33), and epidural disease/cord compression (p=0.84) were all not significantly associated with LF, though patients with cord compression had significantly lower OS (p=0.014). The 1- and 2-year cumulative incidences of VCF were 12.5% and 15.2%, respectively, for all sites, and 14.7% and 17.8%, respectively, for those without vertebroplasty soon after SBRT. 70% (14/20) of all VCFs were symptomatic. The main predictor of VCF was GTV

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occupying >50% of the vertebral body, with a 1-year incidence of VCF of 22% vs 6% in sites with GTV <50% ($p=0.025$). Patterns of failure analyses revealed 21 total LFs, of which 10 failed in-field only, 4 in the epidural space only, 3 marginally/at the edge of the field only, 3 both in-field and marginally/at the edge of the field, and 1 both in-field and in the epidural space. Of all the LFs, there were 4 (19%) that occurred only in the low-dose CTV, outside of the high-dose GTV.

Conclusions: Single-fraction spine SBRT with a dose-painting SIB approach offers excellent local tumor control with low rates of VCF. This technique may provide the optimal balance between efficacy and safety in the treatment of spinal oligometastases.