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Nuclear Image Assessment Following Spine Stereotactic Radiotherapy

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Abstract
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Abstract

Objectives:

Magnetic Resonance Imaging (MRI) is the primary tool for diagnosing and monitoring spinal metastases. However, MRI signal changes can be influenced by various factors such as osteoradionecrosis, fibrosis, or non-tumor-related conditions, complicating interpretation. Nuclear imaging techniques like PET scans or bone scans can provide complementary information to MRI, aiding in the evaluation of treatment response. This study investigates the nuclear response following spine stereotactic body radiotherapy (SBRT) in conjunction with other imaging modalities for a more comprehensive assessment.

Methods:

We conducted a retrospective analysis of patients treated for spine metastases with SBRT between 2014 and 2020. Patients who underwent PET or bone scans both before and after radiation were included. Changes in scan activity were used to categorize patients into complete response, stable disease, partial response, or disease progression. All patients also had contrast-enhanced spine MRIs before and after SBRT, with CT scans permitted when MRI was contraindicated. Additional factors such as age, sex, concurrent systemic therapy (administered within four weeks of radiation), radiotherapy fractionation, treatment volume, pathology (classified as radiosensitive vs. radioresistant), and systemic disease status at the time of radiation (stable vs. progressive) were evaluated. Local control and overall survival were assessed using Kaplan-Meier analysis, and Cox regression was applied for univariate and multivariate analyses.

Results:

The study included 47 patients with a median follow-up of 43.4 months (range: 3.8-97.3 months) and a median age of 61 years (range: 31-79 years). Of the patients, 55% were male, and 91% had an ECOG performance status of 0-1. Concurrent systemic therapy was given to 43% of patients, with 21% receiving chemotherapy, 13% immunotherapy, and 9% targeted therapy. The median prescribed dose was 27 Gy (range: 10-35 Gy), with a median biologically effective dose (BED10) of 51.3 Gy. The isodose line coverage was ⩾95% in 66% of cases, and the median planning target volume (PTV) was 52.6 cc (range: 6.3-215.3 cc), with a median conformity index of 1.03 (range: 0.96-1.2). Partial vertebra coverage was seen in 74% of patients, and 26% had circumferential coverage. Most patients (89%) underwent multi-fraction treatment, with single spinal levels treated in 62%, two levels in 28%, and 3-4 levels in 10%. The cohort included a variety of cancers, with 21% having breast cancer, 15% non-small cell lung cancer, 12% sarcoma, 12% prostate cancer, and 8% head and neck cancer. Systemic disease was stable in 57% of patients and progressive in 43%. PET scans were performed in 62% of patients and bone scans in 38%, with FDG-F18 PET used in 86%, Gallium 68 Dotatate in 10%, and F18 FACBC in 4%. Based on nuclear imaging, 72% of patients showed a complete response, 12% a partial response, 7% stable disease, and 9% disease progression. The median time to complete metabolic response was 13 months (range: 0.4-122 months). In univariate analysis, systemic disease status (HR 5.85, 95% CI 1.18-28.92, p = .03) and nuclear complete response (HR 3.63, 95% CI 1.81-7.29, p < .001) were significantly associated with local control. In multivariable analysis, nuclear complete response remained significant (HR 3.22, 95% CI 1.49-6.97, p = .003), while systemic disease status did not (HR 2.14, 95% CI 2.15-15.65, p = .45). Other factors such as age, sex, concurrent systemic therapy, prescribed dose, fractionation, PTV, and pathology were not significantly associated with outcomes in either analysis. The 2-year local control rate was 91%, and overall survival was 63%.

Conclusion(s):

Spine SBRT continues to demonstrate high rates of local control. PET and bone scan responses were closely associated with sustained disease control, with 91% of patients showing complete, partial, or stable disease, and 9% experiencing progression. Nuclear complete response was a key factor linked to durable disease control in follow-up imaging. Larger, prospective studies are needed to further validate these findings.