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Abstract

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Efficacy and Safety of Donut-Shaped Circumferential Spine CyberKnife Stereotactic Body Radiotherapy for Metastatic Spine Disease

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Abstract

Objectives:

Spinal metastases (SM) with epidural spinal cord compression (ESCC) present a significant challenge due to the high risk of radiation-induced injury to critical structures such as the spinal cord and nerve roots. Traditional treatment approaches often avoid circumferential stereotactic body radiotherapy (SBRT) to reduce these risks. The efficacy and safety of donut-shaped circumferential SBRT, designed to target the spinal column while sparing the spinal cord, remains underexplored. This study aims to evaluate the safety and efficacy of donut-shaped circumferential CyberKnife SBRT for spinal metastases, particularly in preventing radiation-induced myelopathy and achieving local tumor control.

Methods:

We retrospectively analyzed data from patients treated with donut-shaped circumferential SBRT between 2014 and 2023. Key parameters examined included patient demographics, ESCC grade (Bilsky), prior treatments, clinical symptoms, and treatment parameters. We focused on SBRT dosimetric data, radiation exposure to the spinal cord and cauda equina, adherence to dose-volume constraints, and post-SBRT outcomes, including myelopathy and local tumor control.

Results:

Forty-eight lesions in 43 patients (median age: 65; range: 20-78) were reviewed. One patient required separation surgery for severe ESCC (Bilsky grade 3). The median clinical target volume (CTV) was 63.77 cm³, and the median margin dose was 24 Gy. Over a median follow-up of 8 months, local tumor control was 91.1% at 6 months, 87.1% at 1 year, 82.8% at 3 years, and 62.1% at 5 years. Median overall survival was 17 months. Of the 21 lesions exceeding dose constraints, only one patient exhibited clinical myelopathy, which correlated with local tumor recurrence. No radiographic myelopathy or other radiation-induced complications were observed.

Conclusion(s):

Donut-shaped circumferential CyberKnife SBRT is a safe and effective treatment for spinal metastases, achieving high local tumor control with minimal radiation-induced complications, including myelopathy.