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Carbon-ion Radiotherapy for Oligometastatic Lymph Node Metastases: A Retrospective Analysis from a Single Institution

Kento Tomizawa[*,1], Takuya Kumazawa[1], Ken Ando[1], Yuhei Miyasaka[1], Nobuteru Kubo[1], Tatsuya Ohno[1]

[*,1] Radiation Oncology, Gunma University Graduate School of Medicine, Japan

Objectives

This study aimed to report the clinical outcomes of carbon-ion radiotherapy (CIRT) in patients with oligometastatic lymph node involvement.

Methods

We retrospectively reviewed patients who underwent CIRT for oligometastatic lymph node metastasis at Gunma University Heavy Ion Medical Center between 2019 and 2024. Oligometastatic lesions were classified according to the consensus recommendation of European Society for Radiotherapy and Oncology and European Organisation for Research and Treatment of Cancer. Clinical outcomes including overall survival (OS), progression-free survival (PFS), and local failure (LF) were calculated from the start date of CIRT. OS and PFS were estimated using the Kaplan–Meier method, and the cumulative incidence of LF was calculated using a competing risk model.

Results

Seventy-five patients were identified. The median age was 68 years (interquartile range [IQR]: 56–75). Median follow-up was 25 months (IQR: 6.5–30.0) in our cohort. The primary tumor sites were hepatobiliary/pancreatic (29%, n = 22), gastrointestinal (24%, n = 18), gynecologic (24%, n = 18), lung (19%, n = 14), head and neck (3%, n = 2), and genitourinary (1%, n = 1). Prior treatments included surgery (72%, n = 54), CIRT (16%, n = 12), chemotherapy (4%, n = 3), transarterial chemoembolization (4%, n = 3), concurrent chemoradiotherapy (3%, n = 2), and stereotactic body radiotherapy (1%, n = 1). The distribution of oligometastatic disease types among all patients was as follows: metachronous oligorecurrence in 43% (n = 32), synchronous oligometastasis in 19% (n = 14), metachronous oligoprogression in 15% (n = 11), repeat oligorecurrence in 12% (n = 9), repeat oligoprogression in 4% (n = 3), induced oligorecurrence in 4% (n = 3), repeat oligoresistance in 3% (n = 2), and induced oligoprogression in 1% (n = 1). CIRT regimens included 52.8 GyE in 12 fractions (25%, n = 19), 55.2 GyE in 12 fractions (47%, n = 35), and 57.6 GyE in 16 fractions (28%, n = 21). The median OS was 53 months (95% confidence interval [CI]: 25–not reached). The 2-year OS, PFS, and cumulative incidence of LF were 65.4% (95% CI: 53.7–79.5), 35.3% (95% CI: 25.1–49.5), and 16.8% (95% CI: 4.9–28.7), respectively.

Conclusions

CIRT showed favorable clinical outcomes in patients with oligometastatic lymph node metastases. These findings support the potential role of CIRT as an effective local treatment option in this patient population.