Proton Beam Therapy and Carbon-ion Radiotherapy for T2a-T2bN0M0 Non-small Cell Lung Cancer

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Purpose/Objective(s): To evaluate the clinical outcome of particle therapy for T2a-T2bN0M0 (UICC 7th) non-small cell lung cancer (NSCLC).

Materials/Methods: From April 2003 to December 2009, 70 histologically-confirmed primary NSCLC patients were treated with proton beam therapy (PBT) or carbon-ion radiotherapy (CIRT) (45 with PBT and 25 with CIRT) according to protocols. Fifty-one patients were male and 19 were female. Patient age ranged from 57 to 92 years (median, 75 years). Forty patients were medically inoperable and 30 refused surgery. Histology was adenocarcinoma in 39 patients, squamous cell carcinoma in 21, and others in 10. Maximum tumor diameter ranged from 31 to 70 mm (median, 40 mm). Forty-seven patients had a T2a (>3 cm, ≤5 cm) tumor and 23 had a T2b (>5 cm, ≤7 cm) tumor. CIRT was started in 2005, and thereafter both PBT and CIRT plans were made for each patient; either PBT or CIRT was chosen based on the superiority of dose distribution on the planning. The beam energy was 150 MeV for proton and 320 MeV for carbon ion. The beam ranges were adjusted by a fine degrader. The spread-out Bragg peaks of proton and carbon-ion beams were produced by using the bar-ridge filters. The respiratory gating irradiation system was used for all patients to deliver particle beams during the exhalation phase. Radiation doses were prescribed at the center of the tumor. Total dose and fraction (fr) number were 60 GyE/10 fr in 20 patients, 52.8 GyE/4 fr in 16, 66 GyE/10 fr in 16, 80 GyE/20 fr in 14 and other in 4. Toxicities were scored according to the Common Terminology Criteria for Adverse Events Version 4.0.

Results: The median follow-up period for living patients was 38 months (range: 12-94.5 months). For all 70 patients, the 3-year overall survival, local control and progression-free survival were 74%, 80% and 47%, respectively. There appeared to be no difference in treatment outcome between PBT and CIRT. For T2a and T2b patients, 3-year overall survival rate was 69% and 82%, respectively, and 3-year local control rate was 73% and 95%, respectively, with no significant differences between the two groups. Grade 2 or higher pulmonary toxicities were observed in 16 %. Grade 3 pulmonary toxicity was observed in only 1 patient. Other major toxicities were symptomatic dermatitis and rib fracture, observed in 20% and 23%, respectively.

Conclusions: Although tumors larger than 5 cm in diameter are not indicated for stereotactic body radiotherapy using photons, PBT and CIRT are safe and effective for T2a-T2bN0M0 NSCLC. In patients with large tumors, however, regional lymph node metastases developed frequently. It seems therefore necessary to consider combination with chemotherapy or mediastinal radiation. Further investigation of particle therapy is warranted to define their role in T2a-T2bN0M0 NSCLC.