Stereotactic robotic body radiotherapy for patients with unresectable hepatic oligometastases

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Abstract

Objectives: To evaluate the feasibility, efficacy and toxicity of robotic stereotactic body radiotherapy for the treatment of unresectable hepatic oligometastases.

Methods: Between 09/2010 and 06/2015, 43 consecutive patients (19 female, 24 male, median age at treatment: 69.8 ; range, 43-83 years) with up to three synchronous or metachronous hepatic oligometastases were referred for Cyberknife treatment (Accuray Incorporated, Sunnyvale, CA) at our center. In order to enable tumor tracking, gold fiducial markers were inserted around the lesion two weeks prior to each treatment. The treatment was delivered using the Synchrony Tracking System to continuously track fiducial position and adjust for liver motion during treatment. Treatment planning was performed using the Multiplan TPS (v4.6, Accuray) with Raytracing algorithm, and was retrospectively recalculated using a Monte Carlo dose calculation algorithm (v5.1). The primary endpoint of this study was local control (LC), assessed with either contrast enhanced spiral CT or MRI. Secondary endpoints were liver and distant progression free-survival (liverPFS and DFS), overall survival (OS) and treatment toxicity, evaluated using the Common Terminology Criteria for Adverse Events v4.0. (Institute NC, NIH publication 2009). Statistical and survival analysis was performed using python packages (pandas 0.15.2, scipy 0.14.0 and lifelines 0.9.0.0). "

Results: A total of 55 metastatic lesions were treated from primary colorectal (31), breast (11), unknown primary (7), lung (3) melanoma (2) and stomach tumors (1). The mean GTV and PTV volumes were 29.1cc (Standard deviation (SD):30) and 96.1cc (SD:66.3) respectively. All treatments were delivered 3x/week in a median three fractions (range: 3-6) to a median dose of 45 Gy (range: 30-45), prescribed to the 80% isodose line. This corresponds to an equivalent 2-Gy dose of 93.75Gy, when considering an a/ß ratio of 10. The average GTV D98% and D50% were 42.6Gy (SD:8.3) and 48.5Gy (SD:6.1) while for PTV 38.5Gy (SD:7.7) and 46.5Gy (SD:6.0) respectively. The average difference between the Raytracing and the Monte Carlo algorithm was 0.43% on these values. Each treatment was delivered by an average of 158 beams. Dose constraint parameters reported by Grimm et al. were respected (Journal of applied clinical medical physics vol. 12, 2011). At a median follow up of 18.9 (range: 3.2-50.4) months, the 1 and 2-year LC rates were 81.3% and 76.3% respectively and remained stable beyond 2 years. The liver PFS and the DFS were 55.0%/ 42.3% and 62.4%/ 52.0%, while the OS was 86.9% and 78.3% respectively for 1 and 2 year. Three patients reported acute grade 3 GI toxicity. Grade 3

late diarrhea occurred in one patient. One patient with several co-morbidities died from GI hemorrhage within 1 year after SBRT. A careful analysis of the initial plan of this patient confirmed low GI doses, well within published tolerance levels.

Conclusions: Robotic SBRT is feasible, safe and very well tolerated for the treatment of hepatic oligometastases. Our results of LC and OS for unresectable hepatic oligometastases compare favorably to previously published studies of SBRT (Salama J. et al., JCO, 2014(32) ; Goodman B. et al., Practical Radiation Oncology, 2015, in press). It could represent a valid treatment option in the multimodality treatment of unresectable hepatic oligometastases.