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Safety and Efficacy of Novel 3D-Conformal MLC-Based Spatially Fractionated Radiation Therapy (SFRT) Treatment on “Same Day” via Conebeam-CT Guidance for Management of Bulky Tumors

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Abstract
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Abstract

Objectives:

Large and bulky nonlymphoid, unresectable tumors (⩾ 8.0 cm) have very poor prognosis, frequently progress despite systemic therapy, and are often managed palliatively. Conventional radiotherapy treatment options are often limited due to morbidity. Recent publications have indicated that SFRT is a viable treatment option to manage these large tumors. We now report the clinical use of a novel MLC-based SFRT on “same day” as CT simulation, a safe and efficacious treatment for bulky disease that confers rapid reduction in disease burden and pain relief with minimal normal tissue toxicity.

Methods:

Patients with bulky tumors received 15 Gy in 1 fraction via 3D-conformal MLC-based SFRT to the gross tumor volume (GTV-GRID) derived from CT scans with 10%-15% hotspot into the GTV. Millenium-120 leaves were fitted to the GTV generating 1 cm diameter holes, and 2 cm center-to-center distance at isocenter via an in-house MLC fitting algorithm. SFRT plans were generated using 2 to 6 coplanar crossfire gantry angles 60o apart with a 90o collimator, differentially-weighted beams with 6MV and/or 10MV photons. Dose was calculated using Acuros-based engine, generating brachytherapy sieve-like heterogenous dose tunneling without post processing the physician-drawn GTV contour within an hour of CT simulation allowing for same day treatment. Treatments were delivered using pre-treatment Conebeam CT imaging for set up corrections. Patients underwent post-treatment CT imaging in 3-month intervals to evaluate for changes in tumor size and post-radiation sequelae. Outcomes reported include decreases in tumor shrinkage, pain control, and treatment-related toxicity.

Results:

Twenty-six patients with large and bulky tumors of various histologies (non-lymphomatous) in various treatment sites (head and neck, chest, breast, abdominal and pelvic areas, and extremities) who underwent MLC-based SFRT were evaluated. These patients received consolidated radiation therapy treatment after receiving SFRT. Mean GTV-GRID volume was 514.3 ± 315.6 cc (range, 131.1–1251.0 cc). This novel MLC fitting algorithm provided excellent dose parameters with mean GTV(V7.5Gy) and mean GTV dose of 54.2% and 7.9 Gy respectively for 15 Gy plans. Average peak-to-valley-dose-ratio was 3.4. Mean beam-on time was 3.32 minutes. Overall treatment time including patient setup, conebeam CT imaging, and patient re-positioning to beam-off was within 15 minutes. Average 3-dimensional couch correction from original skin-markers was < 1.1 cm. The 3D MLC-based SFRT plans enhanced target dose for bulky masses including deep-seated large tumors while protecting skin and adjacent critical organs. Median follow-up interval from treatment delivery day was 3 months (range, 0–21 months). All patients tolerated the MLC-based SFRT treatment well. Eighteen of 26 (69.2%) patients received post-treatment CT imaging at 3-month interval. Tumor shrinkage was observed in 12/18 (67%) patients who underwent post-therapy evaluation. Improved pain relief was reported in 14/19 (73.6%) patients. Thirteen (50%) patients were confirmed as deceased. Four (15.4%) patients passed away before the 3-month follow-up, and three (11.5%) patients passed away after the 3-month follow-up, none of whom exhibited acute toxicity. Amongst the 22 patients evaluated in total for post-radiation toxicity; acute toxicity included grade 1 skin erythema (n = 4) and grade 1 odynophagia (n = 1), and chronic toxicity included grade 3 wound complication (n = 1) and grade 4 necrotizing fasciitis of the neck (n = 1). Otherwise, 16/22 (72.7%) of clinically evaluated patients reported no post-radiation toxicities, and no grade 5 toxicities were observed.

Conclusion(s):

The novel 3D-conformal MLC-based SFRT to large and bulky unresectable tumors is a fast, safe, and effective treatment that confers decreased tumor burden, improved pain control, and generally low morbidity rates. This simple MLC-based SFRT method can provide effective palliation for a wide range of tumor pathologies, improving patient comfort and compliance as well as better clinic workflow, as a “same day” treatment option avoiding the need of longer contouring, treatment planning and physics quality assurance times. Use of MLC-based SFRT is widely used in our institution. We recommend its extended use in other cancer centers around the globe to provide SFRT treatment to the underserved patient cohort with bulky tumors including deep-seated masses.