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Feasibility of a Lead GRID Collimator for Electron GRID Therapy

Melody Liu [1], Zhengzheng Xu [2], Hualin Zhang [1], Brittney Chau [3], Lauren Garcia [1], Lauren Lukas [1]

1. Radiation Oncology, University of Southern California, Los Angeles, USA 2. Radiation Oncology, Keck Medicine of USC, Norris Cancer Center, Pasadena, USA 3. Radiation Oncology, USC Norris Comprehensive Cancer Center, Los Angeles, USA

Corresponding author: Melody Liu, liumelody247@gmail.com

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Objectives:

Photon based spatially fractionated radiation therapy (SFRT) has been shown to have immunomodulatory effects on the tumor microenvironment. There is a need to develop SFRT strategies using electrons for cutaneous tumors for which the tumor microenvironment is involved in disease progression and immune evasion, such as mycosis fungoides. Lead collimation is widely used in radiation oncology for electron radiation therapy for treatment of superficial and skin malignancies, including mycosis fungoides. Currently there are no clinical studies of electron SFRT (eSFRT) or evaluation of the immunomodulatory effects of eSFRT in mycosis fungoides. The purpose of this study is to assess the feasibility and dosimetry of a GRID collimator designed for eSFRT delivery.

Methods:

A lead GRID collimator was designed using a 10 x 10 cm2 lead sheet of 1.5 mm thickness with a hexagonal pattern of 27 holes with 1.5 cm hole diameter and 2.0 cm center-to-center spacing. Percent depth doses (PDD) and cross beam plane dose profiles at various depths were measured by a water tank scanning system for electron beams of 6 MeV, 9 MeV, and 12 MeV on TrueBeam STX. A 10 x 10 cm2 cone was mounted and the water surface was set at 100 cm. The GRID collimator was placed directly onto the cone cut-out position. The depths of maximum (dmax), 90% (d90), and 80% (d80%) of the maximum dose were determined from the PDD curve. By using the measured dose profiles, the peak to valley dose ratios (PVDR) were evaluated at various depths.

Results:

The dmax, d90, and d80 for 6 MeV were 8.2, 12.8, and 14.9 mm, respectively; for 9 MeV were 11.6, 17.7, and 20.6 mm, respectively; for 12 MeV were 15.6, 22.8, and 26.5 mm, respectively. The mean peak to valley dose ratios (PVDR) at dmax, d90, and d80 for 6 MeV were 2.45, 1.88, and 1.60, respectively; for 9 MeV were 2.01, 1.58, and 1.38, respectively; and for 12 MeV were 1.85, 1.47, and 1.29, respectively. Dosimetric parameters for 9 MeV compared favorably to published data using a 1 mm thick tungsten rubber GRID collimator, which was comprised of 25 holes with 2.5 cm diameter and 3.0 cm center-to-center spacing: PDD dmax (11.6 vs 12.0 mm), d90 (17.7 vs 19.0 mm), d80 (20.6 vs 24.0 mm) and PVDR dmax (2.01 vs 1.77), d90 (1.58 vs 1.51), and d80 (1.38 vs 1.42).

Conclusion(s):

It is feasible for a lead GRID collimator to deliver a dose distribution amenable for eSFRT. Lead sheets are flexible and can be placed either on skin (with an additional covering to protect skin) or on to the linac electron treatment cone. A biocompatible material, such as tungsten, may be more favorable in clinic, but may not be readily available in all clinics due to cost. Further research is warranted to evaluate preclinical models of eSFRT for mycosis fungoides to assess tumor microenvironment immune effects.