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Dosimetric Evaluation and Clinical Implementation of Lattice Radiotherapy Using High-definition MLCs

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Abstract
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Abstract

Objectives:

Historically, a successful treatment of bulky tumors have been challenging, therefore, a radiotherapy approach known as spatially fractionated radiation therapy (SFRT) was designed creating heterogeneous dose distribution in the target. With advancements in treatment planning and delivery systems, a form of SFRT known as 3D lattice radiotherapy (LRT) was developed using volumetric arc therapy (VMAT). Generally, patients have received LRT utilizing the Varian TrueBeam machine with Millennium multi-leaf collimator (MLC). The purpose of this study is to evaluate the dosimetric parameters of the Edge plans with high-definition MLCs (HD-MLCs).

Methods:

Six patients who had previously received LRT using the TrueBeam machine were selected. For all patients, 12 Gy was delivered to the spherical volumes in a single fraction, while achieving a fall-off of 3 Gy to the periphery of the gross tumor volume (GTV). All six patients were re-planned using the Edge machine and the dosimetric parameters of the Edge plans were compared with the clinically delivered plans on the TrueBeam.

Results:

Our findings show that the Edge plan provides a better plan conformality and sharper high dose fall-off from the vertices. Tighter low dose conformality around the GTV as well as less 3Gy spread outside the GTV were observed. It was found the average dose to the GTV was lower with the Edge plans compared to the TrueBeam plans (4.80±0.52Gy vs. 5.05±0.66Gy, p< 0.05) while the average dose to the vertice volume was slightly higher with the Edge plans as compared to the TrueBeam plans (13.11±0.54Gy vs. 12.61±0.63Gy, p=0.07). Subsequently, a higher ratio of the vertice volume average dose to the GTV average dose (Edge: 2.75±0.24 vs. TrueBeam: 2.52±0.25, p< 0.05) was observed for the Edge plan compared to that of TrueBeam. Furthermore, marginally higher peak-to-valley dose ratios (PVDR), defined as D10/D90 of GTV, were observed for the Edge plan compared to the TrueBeam plan (2.72±1.44 vs. 2.53±0.99, p=0.37).

Conclusion(s):

The HD-MLC of the Edge machine as compared with the TrueBeam machine can generate more conformal lattice plans by allowing the delivery of high dose to the vertices and maintaining a low average dose to the GTV. The dose fall-off of the lattice Edge plans is shown to be superior to those of the TrueBeam with regards of high and low dose conformality.