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Abstract

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A Clinical Decision Tool to Determine to the Optimal Treatment Modality for Single Lesion Brain Radiosurgery: Comparison of Volumetric Modulated Arc Therapy, Intensity Modulated Proton Therapy, and Spot-scanning Proton Arc Therapy

Sheng Chang¹, Gang Liu¹, Lewei Zhao¹, Weili Zheng¹, Di Yan¹, Peter Chen¹, Rohan Deryaniyagala², Craig Stevens¹, Inga Grills¹, Prakash Chinnaiyan¹, Xiaoqiang Li³, Xuanfeng Ding⁴

1. Radiation Oncology, Beaumont Health, Royal Oak, USA 2. Department of Radiation Oncology, Beaumont Health, Royal Oak, USA 3. Radiation Oncology, Beaumont Proton Therapy Center, Department of Radiation Oncology, Oakland University William Beaumont School of Medicine, Royal Oak, USA 4. Radiation Oncology, Beaumont Health, Bloomfield Hills, USA

Corresponding author: Sheng Chang, changsheng_yu@outlook.com

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Abstract

Objective: To quantitatively explore the feasibility and re-define the role of using Pencil Beam Scanning (PBS) proton beam therapy in single lesion brain radiosurgery (RS), we developed and validated a dosimetric model to assist the selection of an optimal treatment modality among the conventional Intensity Modulated Proton Therapy(IMPT), Volumetric Modulated Arc Therapy(VMAT) and Spot-scanning Proton Arc(SPArC).

Methods: A series of targets (volume range from 0.3cc to 24.42cc) were inserted in the deep central and peripheral region of a head CT set as in silico model. Three planning groups: IMPT, SPArC and VMAT were generated to deliver 18Gy (RBE) in single fraction using the same planning objective functions and robust optimization parameters. Nine brain metastasis patients were selected for validation. Six physician volunteers participated in the blinded survey to evaluate the plan quality and rank their choices. Additionally, Normal tissue complication probability(NTCP) of brain Radionecrosis(RN) was calculated using the Lyman-Kutcher-Burman(LKB) model and total treatment delivery time were calculated.

Results: The dosimetric model demonstrated that SPArC has significant dosimetric advantage in the V12Gy and R50 with target volume >9.00cc. Nine clinical cases and the blinded survey showed a similar trend and dosimetric results compared to the decision tree. SPArC showed its potential clinical benefit in the management of large lesion more than 20.00 cc to maintain the 18Gy per fraction, meanwhile reduce the probability of brain RN to less than 1%. With an equivalent or better plan quality, SPArC significantly reduced the treatment delivery time (184.46±59.51s) compared to VMAT (1574.78±213.65s).

Conclusion: The dosimetric model presented here is a useful and practical clinical decision tool to help select the optimal treatment modality among VMAT, IMPT and SPArC. SPArC could be considered as a treatment option in the management of large intracranial lesion in SRS.