Cureus

A Novel Ultra-High Dose Rate Proton Therapy Technology: Spot-Scanning Proton Arc Therapy FLASH (SPLASH)

Open Access
Abstract
Published 04/02/2023

Gang Liu [1] , Lewei Zaho [2] , Sheng Zhang [3] , Shuyang Dai [4] , Xiliang Lu [4] , Xiaoqiang Li [5] , Xuanfeng Ding [6]

1. Radiation Oncology, Beaumont Health, Royal Oak, USA 2. Radiation Oncology, William Beaumont Hospital, Royal Oak, USA 3. Proton Therapy, Wuhan Union Hospital, Wuhan, CHN 4. Mathematics and Statistics, Wuhan University, Wuhan, CHN 5. Radiation Oncology, Beaumont Proton Therapy Center, Department of Radiation Oncology, Oakland University William Beaumont School of Medicine, Royal Oak, USA 6. Radiation Oncology, Beaumont Health, Bloomfield Hills, USA

Corresponding author: Gang Liu, liugang9910@163.com

Categories: Medical Physics, Radiation Oncology
Keywords: proton beam therapy, splash, flash radiotherapy

How to cite this abstract
Liu G, Zaho L, Zhang S, et al. (April 02, 2023) A Novel Ultra-High Dose Rate Proton Therapy Technology: Spot-Scanning Proton Arc Therapy FLASH (SPLASH). Cureus 15(4): a947

Abstract

Objectives:

To introduce a novel optimization and delivery technique, the spot-scanning proton arc therapy(SPArc)+FLASH(SPLASH), to take full advantage of FLASH dose rate(40Gy/s) and high dose conformity.

Methods:

SPLASH framework was implemented in an open-source proton planning platform (MatRad, Department of Medical Physics in Radiation Oncology, German Cancer Research Center-DKFZ). It optimizes with (1) the clinical dose-volume constraint based on dose distribution and (2) the effective dose-average dose rate by minimizing the monitor uint(MU) constraint on spot weight and accelerator's beam current sequentially, enabling the first dynamic arc therapy with voxel-based FLASH dose rate. This new optimization framework is able to minimize the overall cost function value combined with plan quality and voxel-based dose rate constraints. Three representative cases(brain, liver and lung cancer) were used for testing purposes. Dose-volume histogram(DVH), dose rate volume histogram(DRVH) and dose rate map were compared among intensity-modulated proton radiotherapy(IMPT), SPArc and SPLASH.

Results:

Results:SPLASH/SPArc could offer superior plan quality than IMPT in terms of dose conformity. The DRVH results indicated SPLASH could significantly improve V40Gy/s in target and region of interest(ROI) for all tested cases in comparison with SPArc and IMPT. The optimal beam current per spot is simultaneously generated, which is within the existing proton machine specifications in the research version(< 200nA).

Conclusion(s):

SPLASH offers the first voxel-based ultra-dose-rate and high-dose conformity treatment using proton beam therapy. Such a technique has the potential to fit the needs of a broad range of disease sites and simplify clinical workflow without applying a patient-specific ridge filter, which has never been demonstrated before.