Cureus

Open Access
Abstract
Published 02/11/2022

Copyright
© Copyright 2022
Hawranko et al. This is an open access abstract distributed under the terms of the Creative Commons Attribution License CC-BY 4.0., which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Distributed under
Creative Commons CC-BY 4.0

Plan Quality and Isotoxic Dose Escalation Investigation Using a 0.35T MR-Linac System in Ablative 5-Fraction Stereotactic Magnetic Resonance-Guided Radiation Therapy for Primary Pancreatic Cancer

Robert Hawranko [1], Keith Neiderer [1], Christopher Guy [2], Edward Bump [2], Amy Watson [2], Lulin Yuan [2], Timothy Harris [2], Emma C. Fields [2], Elisabeth Weiss [2], William Song [2]

1. Medical Physics, Virginia Commonwealth University, Richmond, USA 2. Radiation Oncology, Virginia Commonwealth University, Richmond, USA

Corresponding author: Robert Hawranko, hawrankore@vcu.edu

Categories: Medical Physics, Radiation Oncology
Keywords: plan quality, pancreatic cancer, mr-linac, isotoxic dose escalation

How to cite this abstract
Hawranko R, Neiderer K, Guy C, et al. (February 11, 2022) Plan Quality and Isotoxic Dose Escalation Investigation Using a 0.35T MR-Linac System in Ablative 5-Fraction Stereotactic Magnetic Resonance-Guided Radiation Therapy for Primary Pancreatic Cancer. Cureus 14(2): a714

Abstract

Objective: This study investigates plan quality generated by an MR-Linac treatment planning system (TPS) for 5-fraction SBRT of primary pancreatic cancer (PCa). A cross comparison was performed against a conventional Linac TPS. In addition, an isotoxic dose escalation was investigated with the MR-Linac TPS based on the stereotactic MR-guided adaptive radiation therapy (SMART) trial constraints.

Methods: 20 PCa patients previously treated with a conventional Linac were retrospectively re-planned for the 0.35T MR-Linac. For each patient, three plans were generated: using the original prescription dose and organ at risk (OAR) constraints (Plan 1), following SMART trial's OAR constraints but with the original prescription dose (Plan 2), and, starting with Plan 2, following an isotoxic dose escalation strategy where dose was escalated until any one of the SMART trial's OAR constraints reached its limit (Plan 3). The conventional Linac plans (25-33 Gy in 5 fractions) accounted for respiratory motion by creating an ITV that encompassed the GTV's motion range, based on a 4DCT study before applying a PTV margin of 5 mm. Dose calculations were performed on a derived average intensity projection image. For the 3 plan types generated with the MR-Linac TPS, the GTV defined at the 0% phase was expanded with a uniform PTV margin of 3 mm (i.e., no ITV was used), as respiratory motion with the MR-Linac system is handled with real-time MR guidance for target-tracking and beam-gating in addition to mild-inhalation breath-hold. Conformity index and R50 conformity metrics were calculated for all 60 MR-Linac plans, in addition to standard dose-volume indices.

Results: 60 MR-Linac plans were created which met their respective dosimetric criteria described above. For Plan 1, the MR-Linac TPS successfully achieved equivalent or lower OAR doses while maintaining prescribed PTV coverage, for the 20 plans. In particular, maximum dose to the small bowel was reduced on average by 4.97 Gy (range: 1.11-10.58 Gy). For Plan 2, the MR-Linac TPS successfully met all SMART trial OAR constraints while maintaining equivalent PTV coverage. For Plan 3, the MR-Linac TPS was able to escalate the prescription dose from the original 25-33 Gy by, on average, 36 Gy (range: 15-70 Gy), and in particular, dose to the PTV has been successfully escalated to at least 50 Gy for all 20 plans. These achievements were made possible in part due to the omission of the ITV afforded by the MR-Linac's real-time target tracking technology and sharper dose penumbra due to its unique dual-focus MLC design.

Conclusion: The 0.35T MR-Linac TPS can generate plans that are equivalent to conventional Linac-based plans for SBRT of PCa. Through analyzing Plan 2 and 3 strategies, and due to the real-time target localization capabilities of the MR-Linac system, increased OAR sparing and/or target dose escalation are possible. The MR-Linac system has proven, in this study, to be an effective platform for safely escalating doses where such is anticipated to translate to possible clinical benefit for PCa patients. Our next focus is to streamline the isotoxic dose escalation planning workflow for clinical implementation.