ABSTRACT SUBMISSION FORM

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6th MR in RT Symposium 2018

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PRESENTATION TITLE

Multi-Fractional Planning Study for Lung Cancer Treatment: Impact of Magnetic Fields and Treatment Procedures

AUTHOR(S)

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ABSTRACT

Please type in your abstract up to a MAXIMUM of 500 words. Figures may be included.

Purpose:

The application of hybrid MRgRT devices allows continuous high-contrast soft tissue imaging during irradiation. Possible use of this real-time information is the reduction of treatment margins and the extraction of direct feedback for tumor gating and tracking. However, it is known that the permanent magnetic field of the MRI can have significant impact on the delivered dose to inhomogeneous tissues like lung. In this work, we investigate the impact of different magnetic fields and treatment procedures on the plan quality for lung cancer patients.

Materials & Methods:

IMRT treatment plans were generated with the matRad treatment planning system coupled with the EGSnrc Monte Carlo code accounting for magnetic fields during dose calculation. Six lung cancer patients with 3 fractional 4DCTs each were considered. A conventional radiotherapy approach applying a single initial plan delivered to all fractions was compared to fractional replanning. Further, gating and tracking procedures applying a reduced margin of 5 mm to the GTV were simulated. For gating, only 4DCT phases inside the gating window were considered for simulations, while tracking was simulated by moving the patient geometry. Optimized plans were forward calculated to the fractional 4DCTs, and dose was accumulated to the according planning CT by means of deformable image registration and energy/mass transfer mapping. For analyses, mean dose volume metrics were compared for the different magnetic fields as well as for different treatment planning strategies.

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Results:

The resulting mean dose metrics averaged over all patients and fractions for the GTV and the total lung are presented in figure 1. The dose homogeneity of the GTV could be kept consistent for all set-ups. The average D_{mean} of the GTV varies by less than 0.5 Gy from the prescribed dose of 65 Gy. A reduction of the mean lung dose for inline magnetic fields could be found of up to 10% at 1.0 T. Perpendicular magnetic fields did not affect the mean lung dose substantially. Furthermore, it was observed that fractional replanning reduced the mean dose in lung by 4.5% while gating and tracking led to a mean lung dose reduction of up to 22%.

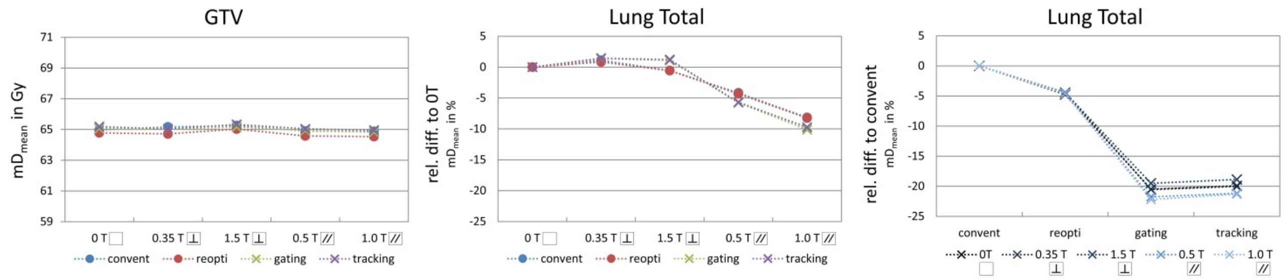

Figure 1: Average D_{mean} values over all 6 patients, 3 fractions (with 10 4DCT phases) each, depicted for the GTV and total lung. Left: D_{mean} of the GTV for conventional, reoptimized, gated and tracked approaches. Middle: Relative differences of D_{mean} values in the total lung relative to the reference of the 0 T plans as a function of magnetic fields. Right: Relative differences of D_{mean} values in total lung relative to the reference of conventional treatment as a function of treatment strategies.

Conclusions:

This multi-fractional treatment planning study provides an insight into the physical effects of different magnetic fields strength and orientation as well as different adaptive strategies on the overall delivered dose to lung cancer patients when treated with MRgRTs. For all set-ups, comparable patient dose distributions could be achieved and no expected detrimental effects were found due to the magnetic fields. The results show that an inline orientation of the magnetic field is beneficial in terms of reduced dose to lung. The possible reduction of margins with gating and tracking was followed by a distinct decrease of lung dose for all set-ups. These results suggests that gating and tracking, especially in combination with inline MR-linac set-ups, could provide superior clinical outcome for lung cancer patients, unless microscopic spread of tumor cells or delivery uncertainties contraindicate margin reduction.