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Robust dynamic-collimator trajectory radiotherapy (colli-DTRT)

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Purpose: To develop robust dynamic-collimator trajectory radiotherapy (colli-DTRT), including robust dosimetrically motivated path-finding, to manage patient set-up uncertainties.
Methods: colli-DTRT plans were created for one brain (30 x 2 Gy) and one breast (16 x 2.65 Gy) clinically motivated cases. colli-DTRT paths were generated through iterative fluence map optimization (FMO) and beam angle elimination. Direct aperture optimization (DAO) was applied to the paths to obtain a deliverable plan. Standard planning target volume (PTV) plans (colli-DTRT$_{\text{PTV}}$) were optimized using a PTV extending the clinical target volume (CTV) by 3 mm (brain) and 5 mm (breast). Robust plans (colli-DTRT$_{\text{robust}}$) were optimized directly on the CTV using robust FMO during path-finding and robust DAO for final plan optimization considering 5 mm systematic shifts in all three directions. All plans were normalized to 50% of the PTV/CTV. Plan quality and robustness were evaluated by comparing dose-volume endpoints of the nominal scenario and the standard deviation (σ) of the mean over all scenarios.
Results: For the brain case, $D_{98\%}$ to the CTV was 58.0 Gy (σ = 1.1 Gy) for colli-DTRT$_{\text{PTV}}$ and 57.3 Gy (σ = 2.2 Gy) for colli-DTRT$_{\text{robust}}$. $D_{2\%}$ to the right optic nerve was 38.1 Gy (σ = 10.5 Gy) for colli-DTRT$_{\text{PTV}}$ and 32.5 Gy (σ = 6.0 Gy) for colli-DTRT$_{\text{robust}}$. For the breast case, $D_{98\%}$ to the CTV was 41.0 Gy (σ = 0.3 Gy) for colli-DTRT$_{\text{PTV}}$ and 40.6 Gy (σ = 0.3 Gy) for colli-DTRT$_{\text{robust}}$. D_{mean} to the right lung was 12.2 Gy (σ = 0.9 Gy) for colli-DTRT$_{\text{PTV}}$ and 11.8 Gy (σ = 0.8 Gy) for colli-DTRT$_{\text{robust}}$.
Conclusion: Robust colli-DTRT with robust dosimetrically motivated path-finding was successfully developed, improving organs at risk sparing and robustness compared to the PTV approach for two investigated cases. However, target coverage was higher in colli-DTRT$_{\text{PTV}}$ than colli-DTRT$_{\text{robust}}$ for both cases. Robustness of target coverage was the same for the breast case but better with colli-DTRT$_{\text{PTV}}$ than colli-DTRT$_{\text{robust}}$ for the brain case.
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