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Robust optimization of lung SBRT treatments using CyberKnife with Synchrony and X-Sight Spine tracking methods

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Purpose: To assess the dosimetric gain on ipsilateral lung using robust optimization on the GTV (GTV-based) or ITV (ITV-based) instead of standard PTV optimization (PTV-based) for lung stereotactic body radiotherapy (SBRT) on the CyberKnife with Synchrony and X-sight spine tracking methods.

Methods: For on-line synchrony tracking, 15 lung SBRT were calculated with both GTV- and PTV-based methods. The GTV-based plans were optimized using a robust margin corresponding to the GTV-PTV margin. For x-sight spine static tracking, 5 lung SBRT were calculated with GTV-, ITV- and PTV-based methods. Both GTV-and ITV- based plans were optimized with a robust margin corresponding to the ITV-PTV margin. For GTV-based plans, all phases of the 4D-CT were included in the optimization. For all plans, a robust evaluation was performed to assess dose to ipsilateral lung, as well as the GTV coverage for all treatment scenarios (combination of positional uncertainty and respiratory motion). Dose to the ipsilateral lung (Dmean, V20Gy and V5Gy) as well as the GTV coverage were recorded.

Results: For synchrony tracking, the average Dmean of the ipsilateral lung was reduced by 0.7 Gy with GTV-based method. The V5Gy was reduced from 22.31% for PTV-based to 18.02% for GTV-based plans. The V20Gy was reduced from 4.45% for PTV-based to 3.24% for GTV-based plans. The coverage of the GTV was fulfilled for all scenarios for both GTV- and PTV-based plans. For x-sight spine tracking, the average Dmean was reduced by 0.95 Gy for ITV- and by 1.03 Gy for GTV-based plans compared to PTV-based plans. The V20Gy was reduced from 9.17% for PTV-based plans to 7.42% and 7.25% for ITV- and GTV-based plans respectively. The V5Gy was reduced from 31.77% for PTV-based plans to 28.45% and 28.41% for ITV- and GTV-based plans respectively. The GTV coverage was in the tolerance for all scenarios.

Conclusion: Robust optimization, considering the positional uncertainty and the respiratory motion during optimization, allowed to reduce dose to ipsilateral lung while maintaining an adequate GTV coverage.

Primary author: GONDRÉ, Maude (IRA)

Co-authors: Prof. BOCHUD, François (IRA); Prof. BOURHIS, Jean (CHUV); Prof. MOECKLI, Raphael (IRA); Dr VALLET, Véronique (IRA)

Presenter: GONDRÉ, Maude (IRA)

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